INDIVIDUALIZED SCIENCE INSTRUCTIONAL SYSTEM

Human Reproduction

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Human Reproduction

ANNOTATED TEACHER'S EDITION

Ginn and Company

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ANNOTATED TEACHER'S EDITION

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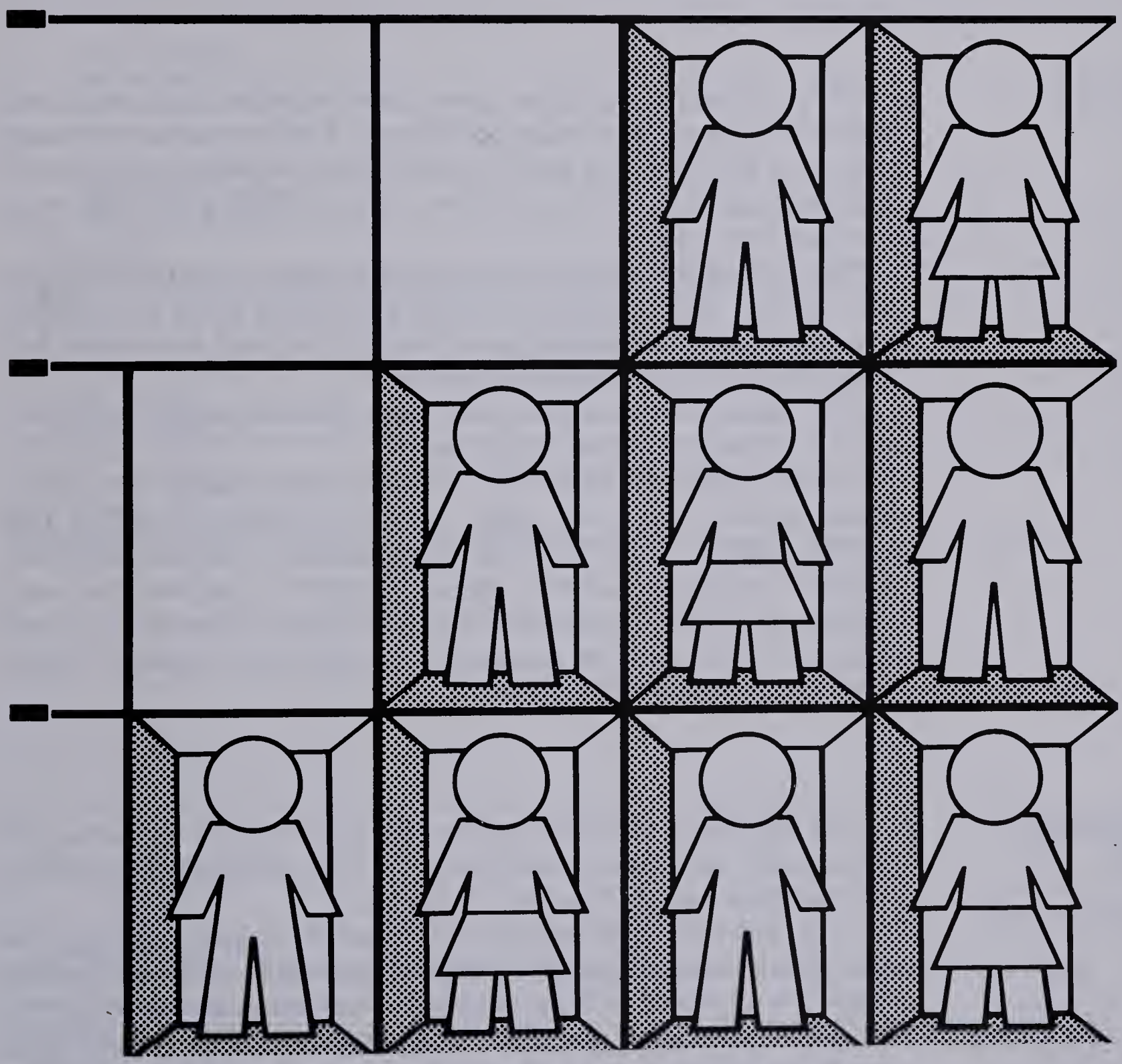


OVERVIEW

Human Reproduction contains the basic biological information needed to understand the conception and gestation of a new human being. The female and male reproductive systems and the hormonal control of them are considered.

Much of the material in this minicourse may be considered sensitive in some communities. Teachers are in the best position to know the procedures to follow when dealing with such materials locally. For example, in some areas, parents must be informed about and shown the materials before they can be used in the classroom. You are urged to follow all appropriate procedures relevant to your community.

ORGANIZATION

This minicourse contains seven core activities, four advanced activities, and six excursion activities. The first activity in each section is the planning activity and should be done before any of the other activities in that section. The remaining activities may be done in any order.

The core activities deal with the nature and production of eggs and sperm, the movement of eggs and sperm prior to fertilization, prenatal development and functioning, and the events and feedback control of the menstrual cycle.

The advanced activities deal with gametogenesis and with male and female hormonal functions.

In the excursion activities, students can observe embryonic development in chicken eggs. (You may want to set up this activity early. See "Advance Preparations" for Activity 13.) Another excursion activity allows students to explore the similarities and differences between identical and fraternal twins and triplets. The last three excursions are about two types of family planning and venereal diseases.

MATERIALS AND EQUIPMENT

The following tables show the quantity and the frequency of use of each item used in each activity. The activities that require no materials are not listed in the tables.

It is important to collect and organize all the materials for each minicourse before the students begin any of the activities, since the students will be working simultaneously on different activities. Having all materials readily available allows students to do the activities in the order they choose. The amount of material you will need to make available will depend on the number of lab groups that will be doing each activity. As lab groups use the "skipping option" and as they scatter themselves throughout the

activities, the total amount of materials needed at one time for each activity will decrease.

NONCONSUMABLE ITEMS	MINIMUM MATERIALS PER LAB GROUP† PER ACTIVITY	
	7	13
Culture dish (optional)		1
Forceps, dissecting		1
Grease pencil		1
*Incubator, commercial, or the following materials to construct one:		1
board, wooden		2
box, wooden, heavy		1
bulb in socket		1
glass, pane (optional)		1
pan, small, of water		1
thermometer, Celsius		1
Jar, baby food, with lid		4
Lens, hand		1
Microscope, binocular dissecting (optional)		1
Pan, pie		2
Petri dish		1
Scissors, dissecting		1
Spoon, plastic		1
Resource Unit 2	1	
Resource Unit 13	1	

*See "Advance Preparations."
†A *lab group* is defined as one student, a pair of students, or any size group of students that you choose.

CONSUMABLE ITEMS	MINIMUM MATERIALS PER LAB GROUP† PER ACTIVITY
	13
Alcohol, isopropyl (ml)	100
Cotton pad or sponge, about 12 cm × 12 cm	1
*Egg, chicken, fertilized	5
Food for baby chick (g)	4

*See "Advance Preparations."
†A *lab group* is defined as one student, a pair of students, or any size group of students that you choose.

ADVANCE PREPARATIONS

Activity 13

You may want students to start this activity near the beginning of the minicourse in order to coordinate its completion with that of the minicourse.

You may wish to have students work in lab groups of four or more as they examine the fertilized chicken eggs. Such larger-than-usual lab groups will conserve incubator space and reduce substantially the number of fertilized eggs needed.

Obtain fertilized chicken eggs that have not been refrigerated or chilled from a hatchery or a health-food store. If six or seven eggs are purchased for each lab group, the chances of having five develop are improved.

Eggs can be obtained a couple of days before they are needed if the eggs are stored at a cool temperature, but not lower than 20°C. If cool storage does occur, the eggs will require additional incubation time — ten to twelve additional hours for eggs kept at 20°C. Do not store the eggs for more than three days. Cool storage reduces the chances of hatching.

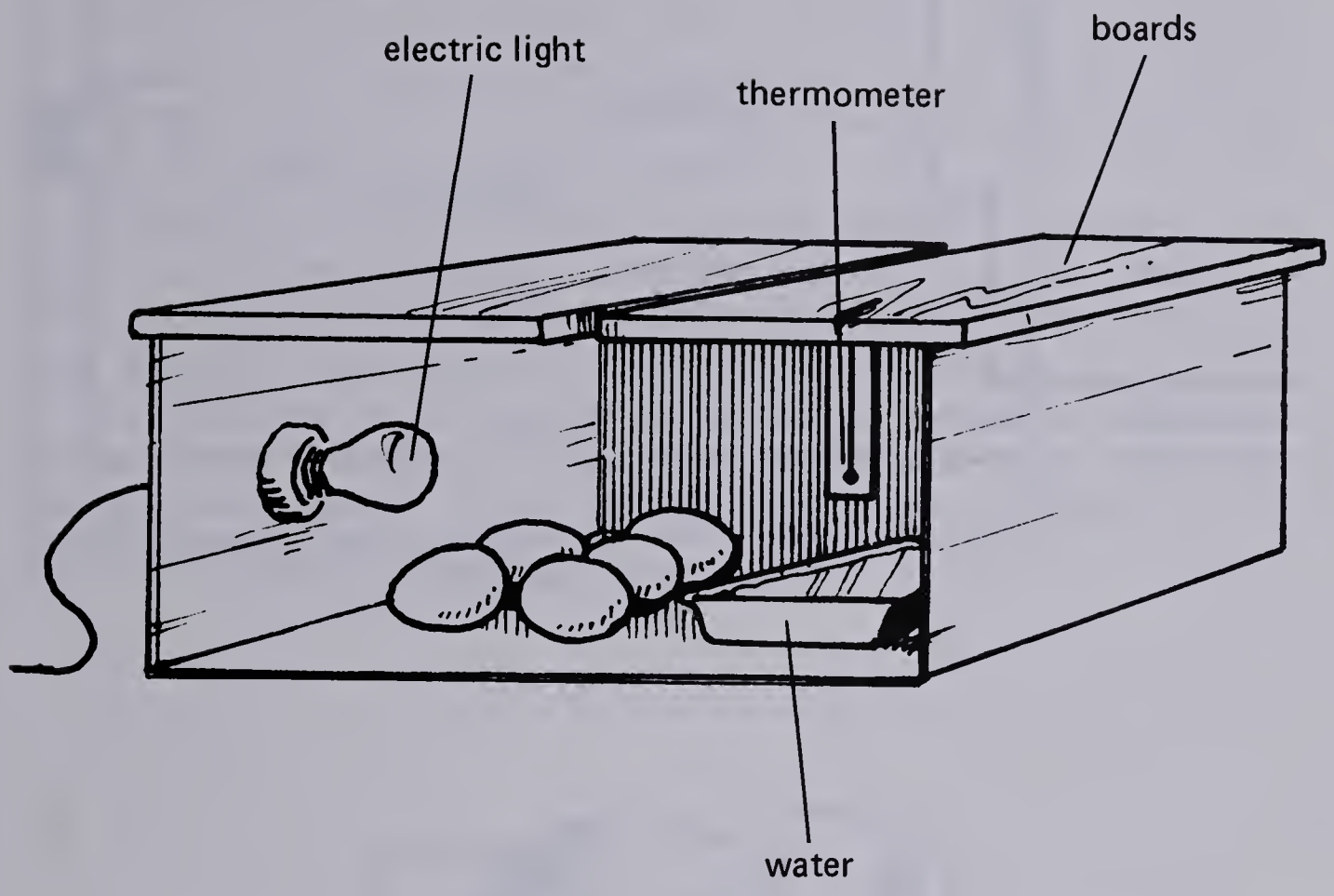
The incubator must remain at a constant 37°C for the entire incubation period. Run the incubator for two days before beginning the incubation of the eggs to check for constancy of temperature.

If a commercially constructed incubator is not available, you can construct one. The following design should prove satisfactory.

Use a wooden box, large enough to hold at least five eggs for each lab group. If the wood is thin, line the inside with heavy cardboard. To prevent fire, you may want to paint the cardboard or wooden lining with several coats of a fireproofing solution. A fireproofing solution may be made by mixing the following:

150 grams borax
120 grams boric acid
1 litre water

Install an electric light and a Celsius thermometer, as shown in the diagram on page 5. Keep a small pan of water inside to provide a high level of humidity and to help control the temperature. Cover the top of the box with two boards that can be slid apart or together as temperature conditions require. On the nineteenth day, a pane of glass may be substituted for one of the boards so that students may observe the hatching of the chicks.

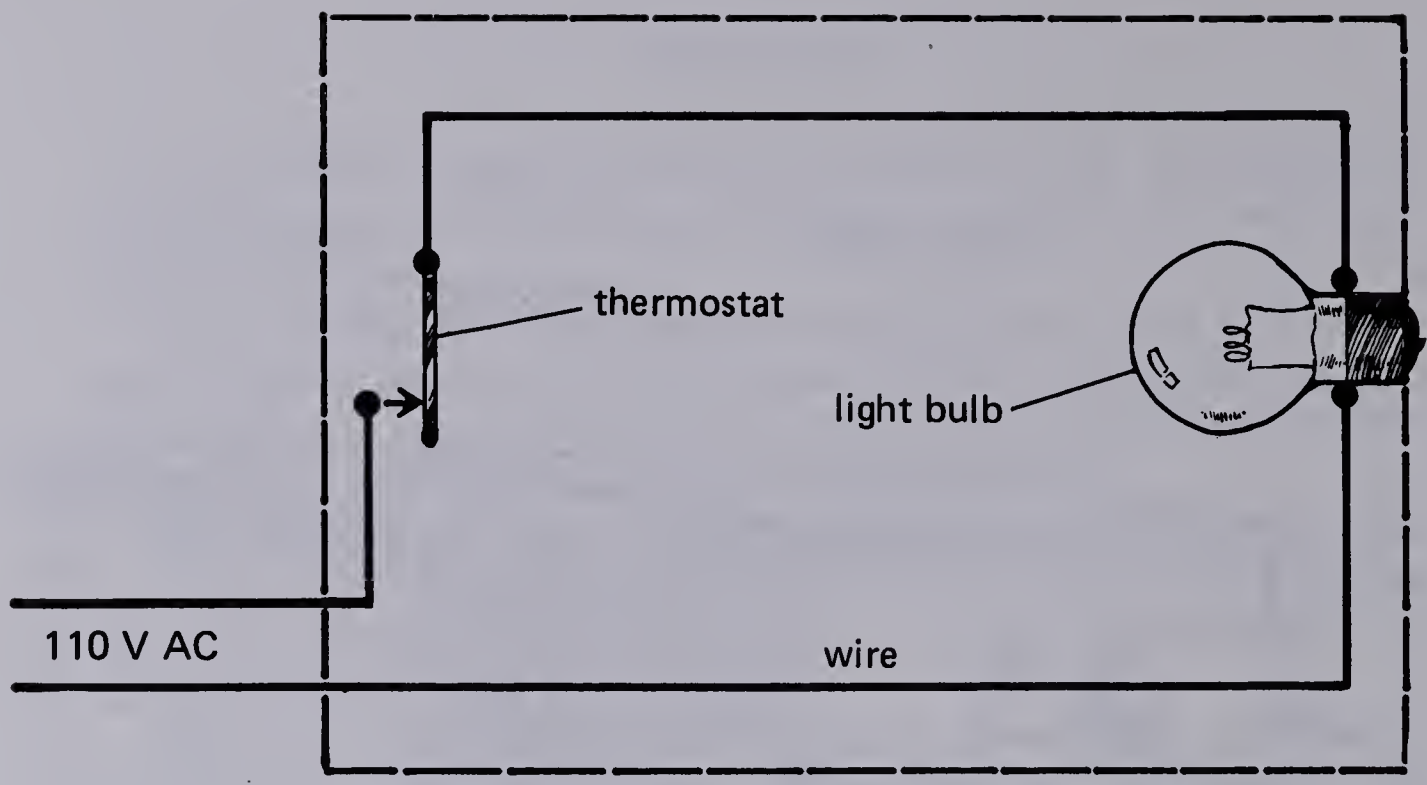


After the incubator has been constructed and the light bulb turned on, check the temperature. Adjust the temperature of the box by using a larger bulb if the box is too cool or by spreading the boards at the top if the box is too hot. When the temperature stays at 37°C for about two days, the incubator is ready for the eggs.

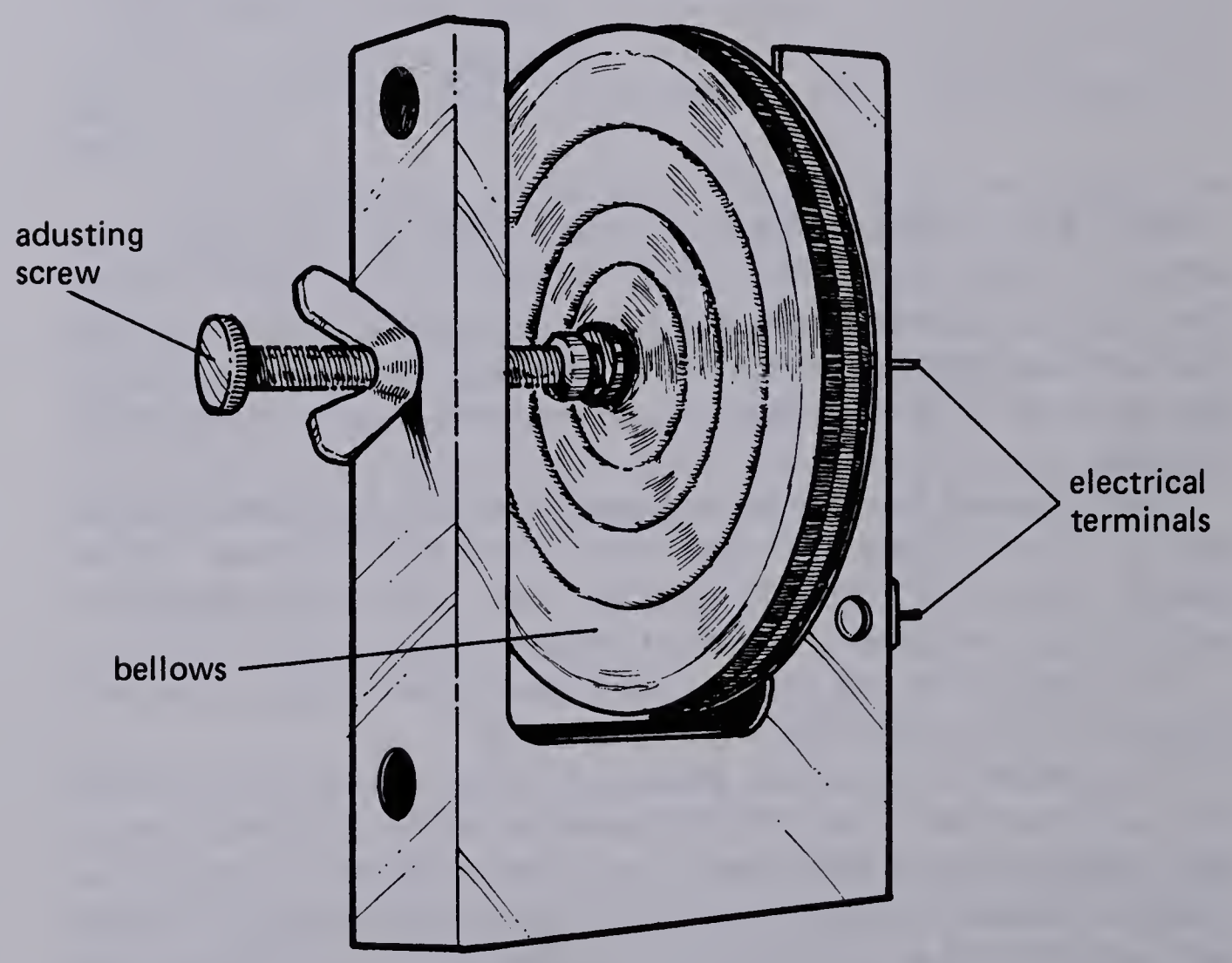
Schedules will have to be arranged so that the students will be able to turn the eggs over each day. Since students may not be present when the fifth egg hatches, water and food should be put into the incubator about the nineteenth day.

You should end the activity with several live chicks. It would be good to find homes for them in advance.

If you want to go to the trouble of constructing an incubator that will maintain a constant temperature without sliding boards, you can purchase a thermostat at a feed and grain store. This can be mounted on the inside of the box and will turn the light bulb on and off to maintain the temperature. It will have the advantage of keeping the eggs at an almost exact temperature whatever the external conditions are and, once adjusted, will need no supervision. A schematic wiring diagram is given on page 6, along with a picture of one type of thermostat that is inexpensive.



THERMOSTAT WIRING DIAGRAM



Any change in temperature causes the bellows of this thermostat to expand and contract, making or breaking the electrical contact and turning the light on or off.

Prenatal Development

In Activity 4, certain events in the development of the embryo or fetus are given for certain times during the nine months of pregnancy. In reality, such hard-and-fast rules do not exist. Different sources list different times for the appearance of various structures during development.

You will find that the same situation exists in Activity 13, when the students study the development of a chicken embryo. The embryos that the students observe will probably differ from one another in the degree of development. One reason for this is that chicken embryos proceed to various stages of development before the eggs are even laid by the hen. Also, although living sytems follow general patterns, there are variations in the patterns among individuals.

Menstruation

Hormonal control of the menstrual cycle is not completely understood by physiologists. It is generally accepted that FSH (follicle-stimulating hormone) causes the follicles of the ovaries to grow and that LH (luteinizing hormone) further stimulates that growth to the point of ovulation. The effects of estrogens and progesterone on the endometrium of the uterus — as well as on the fallopian tubes, the breasts, the skeleton, and other organs of the body — are also fairly well established. Under the influence of estrogens, the endometrial glands and the surface and underlying cells of the endometrium proliferate. When progesterone is also present, those cells increase in volume, the endometrium swells, and glandular secretion increases.

In reality, hormones do not have quite the highly direct relationships presented in Activities 7, 10, and 11. Hormones generally do not act on each other but may act on the glands or cells that secrete them or on intermediate cells such as the hypothalamus.

The simplified presentation of hormones in the student booklet should make the cyclical nature of the menstrual cycle understandable for high school students. For instance, FSH secretion is followed by LH secretion; together, it is hypothesized, these two hormones stimulate production of estrogens in the ovaries. Estrogens, in turn, stimulate increased production of LH. As the

amounts of estrogens and then progesterone increase, the production of FSH and LH is inhibited. As the levels of FSH and LH decrease, the production of estrogens and progesterone also begins to decrease.

There is a fifth hormone, luteotrophic hormone (LTH), or prolactin. It is secreted by the pituitary gland. The role of this hormone is to stimulate lactation, or the secretion of milk, in human beings. At the present time, however, there is little evidence to implicate LTH in ovarian function directly and therefore to connect it explicitly with FSH, LH, estrogens, and progesterone.

The releasing hormone for both FSH and LH is secreted by the hypothalamus. The hypothalamus is in the midbrain, and the stalk of the pituitary connects to it. As the releasing messages are sent to the pituitary, the hypothalamus in turn is regulated by the levels of circulating gonadal hormones, estrogens and progesterone. Numerous environmental factors, such as light and temperature, also serve to regulate the hypothalamus.

Reproduction Research

It is perhaps surprising that a process as ancient as life itself should, in recent years, be in the forefront of controversial research. There probably have been as many news articles written, as much serious study done, and as great a controversy generated about human reproduction as any other single subject. From contraception and in vitro fertilization to recombinant DNA and surrogate mothers, biomedicine has aroused considerable interest.

Recombinant DNA technology — "genetic engineering" — probably will offer opportunity to insert genes into embryos and fetuses. Then a gene associated with metabolic or blood disease could be altered or replaced. But with the hope of cure of genetic disease also come many scientific and public questions. The technique smacks of trying to create a "master race" of "superbeings," or of trying to too narrowly define the best kind of human being. There also is the risk that we will try to affect characteristics such as intelligence, which are more complexly determined by both genes and environment. There also is the apprehension that the

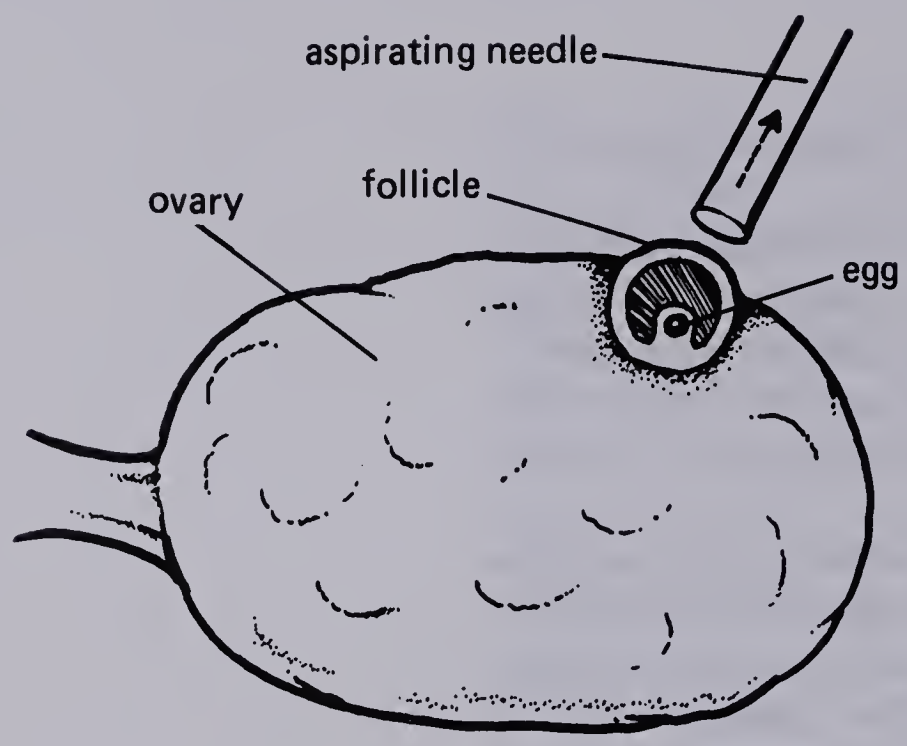
detection of genetic "defects" in a fetus will inevitably result in its being aborted.

With the publication of a popular book on cloning in 1978, the topic was again debated. The book was published as a factual account, not fiction, but is doubted by most scientists. They know that much more basic research must be carried out before the procedure would be possible; most think cloning of humans should not be done in any case.

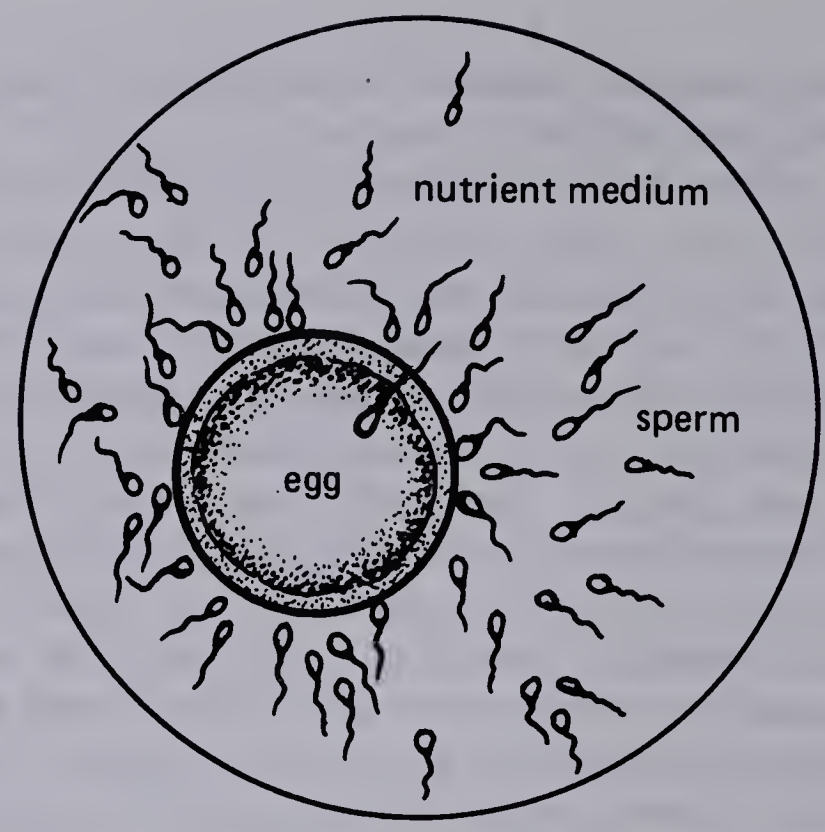
At present, the relatively simple procedure of amniocentesis allows the medical practitioner to determine specific genetic disorders in the developing fetus. It usually is performed at fifteen to seventeen weeks of pregnancy by a skilled obstetrician. A needle is inserted through the abdominal and uterine walls into the amniotic-fluid sac surrounding the fetus. A small amount of fluid is withdrawn for the tests. Chromosomes can then be visualized.

Also in 1978 a baby girl was born in England as a result of an in vitro fertilization. The mechanics were surprisingly simple; see the diagram on page 10. Quite a few experiments preceded this first success. No longer can the statement be made that conception occurs only when a sperm from the male fuses with an egg from the female *in the female's body.* Fertilization outside the body could be a boon to husband and wife who desire a child, but for functional reasons find usual conception impossible. However, the next steps are causing some concern. For a time the procedure was banned in the U.S. while ethical and legal aspects were discussed. In 1980 a clinic capable of carrying out in vitro fertilization had opened in the U.S. All indications are that many attempts will be made in England, Asia, and the U.S., undoubtedly with many successes and failures. Other possible developments remain to be discussed. After fertilization the embryo could be implanted into a surrogate mother. Or attempts might be made to alter the genes of the early embryo — the genetic engineering discussed earlier.

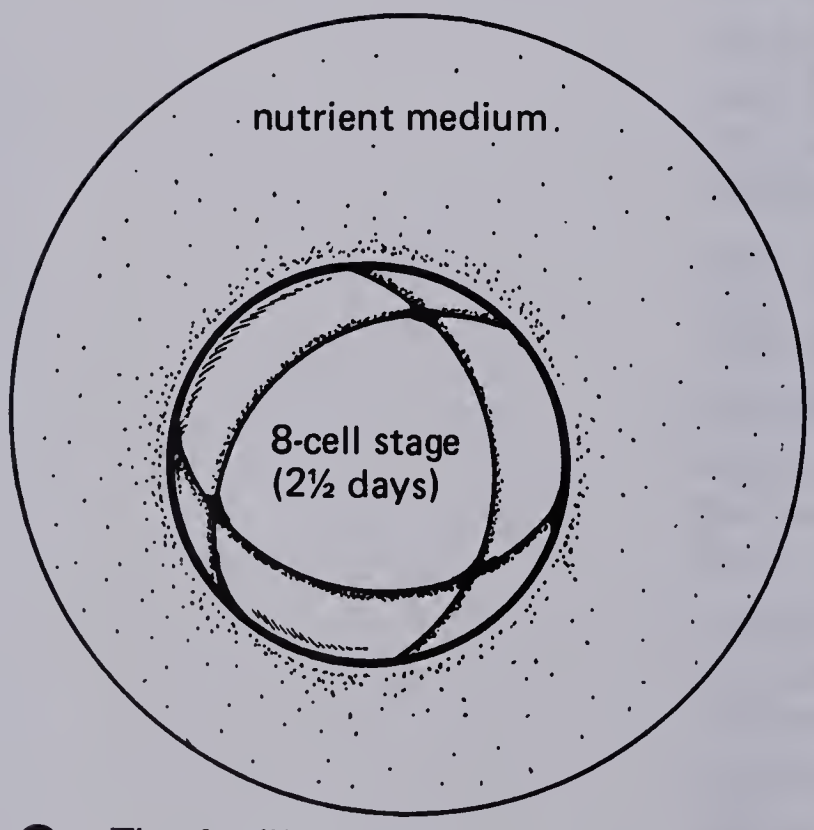
Scientists believe that research will produce even more interesting discoveries and techniques in the field of human reproduction. However, there always will be strong opposition to any procedure that seems to encroach on the usual male-female relationship. And the social issues of availability and cost will continue to find wide discussion in communities, on ethics advisory boards, and in policy-making agencies.



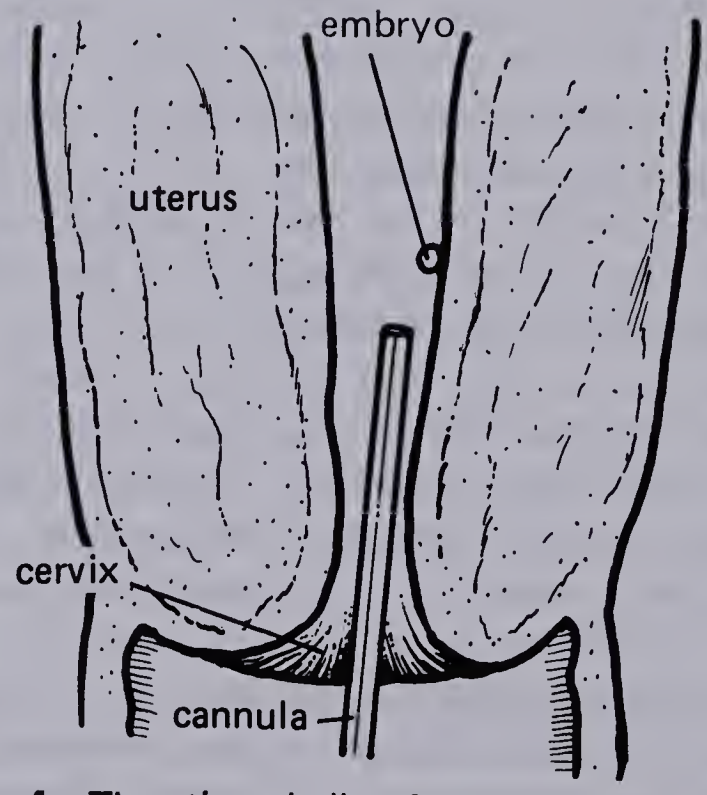
1. A mature egg was removed from the woman's ovary by use of an aspirating needle. This needle allowed the egg to be sucked into a tube. A relatively small incision was necessary for the insertion of the needle and a laparoscope — the surgical tool that allowed the physician to see the ovary.



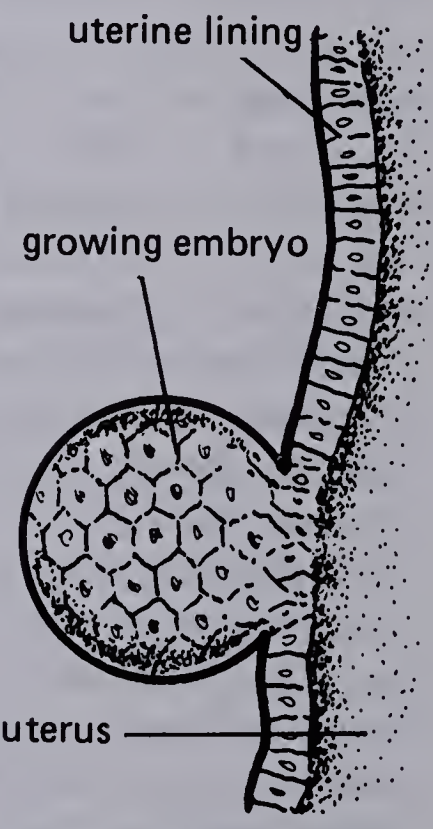
2. The egg was transferred to a small container, where it was mixed with nutrients and the husband's sperm. A single sperm penetrated the egg, fertilizing it.



3. The fertilized egg was placed in another solution. After lying dormant for about twenty-four hours, it began to divide. In a little more than two days from fertilization, it had changed into two, four, and then eight cells.



4. The tiny ball of cells was then placed in the uterus through the cervix, using a hollow plastic tube called a *cannula*. The mother-to-be had received hormones to prepare the uterus to receive the embryo.



5. After several days, the growing sphere of cells attached itself to the uterine wall, receiving nutriment from the mother. It was then carried to almost the full nine months before delivery by cesarean section.

In addition to the *Minicourse Test*, answers to which are provided with the test, you may want to use the following essay questions.

Essay Questions

Three essay questions are provided here with model answers for your convenience. They are based on materials found in the core activities.

1. The male and female reproductive systems, although different, do have some similarities. What are those similarities? How do the functions of the two systems differ?

Answer: Both systems produce sex cells (sperm or eggs). Each sex cell contains half the genetic information, or chromosomes, for a baby. Sex cells are produced in pairs of organs (ovaries or testes) that are similar in shape and size and that also function as glands in the production of hormones. The organs are joined by tubes to a single tube.

The major difference between the systems is that the organs of the female function to support and protect the developing baby, whereas the organs of the male function to place the sex cells inside the female.

2. Explain why a woman is most likely to become pregnant during the twelfth through seventeeth day of a twenty-eight-day menstrual cycle.

Answer: Generally, the egg is released about the fourteenth day of the cycle. Sperm can live in the body of a female for up to forty-eight hours. If they enter the body of a female on the twelfth day, they could still be alive to fertilize an egg on the fourteenth day.

An egg can be fertilized up to three days after it is released from the ovary. If sperm enter a female's body between the fourteenth and seventeenth day, one sperm could fertilize the egg.

3. An egg and a sperm are both sex cells. How are they similar? How are they different?

Answer: Both cells contain twenty-three chromosomes. Both are necessary for fertilization. Both travel through a tube in the body from the place they are formed.

The egg has no method of propelling itself. The sperm can move by its own action. The egg is many times larger than the sperm. The egg remains in the female body to be fertilized. The sperm leaves the male body to fertilize the egg. The egg is penetrated by the sperm. The egg has only an X sex chromosome. The sperm has either an X or Y sex chromosome.

REFERENCES

Anthony, Catherine P., and Alyn, Irene B. *Structure and Function of the Body.* 5th ed. St. Louis: C.V. Mosby and Co., 1976.

This is a general reference for the topic of human reproduction.

Anthony, Catherine P., and Kolthoff, Norma J. *Textbook of Anatomy and Physiology.* 9th ed. St. Louis: C.V. Mosby and Co., 1975.

This basic reference is written for introductory college courses.

Biological Sciences Curriculum Study. *Human Sexuality; Minicourse Cluster.* Philadelphia: W.B. Saunders Co., 1976.

This cluster of five self-instructional, audio-tutorial mini-courses is designed for beginning college students, but it may be useful for some advanced high school students. Titles include *The Human Reproductive System, Sexual Maturation — What's Normal?, Pregnancy, Birth Control,* and *Venereal Disease.*

Crouch, James E. *Functional Human Anatomy.* 2nd ed. Philadelphia: Lea and Febiger, 1972.

This college-level text discusses the anatomical aspects of embryonic development (Chapter 4) and the reproductive systems (Chapter 16).

Guyton, Arthur C. *Textbook of Medical Physiology.* 5th ed. Philadelphia: W.B. Saunders and Co., 1976.

Chapters 77 through 80 contain a medical-school-level discussion of the physiology of reproduction.

_____. *Basic Human Physiology: Normal Function and Mechanisms of Disease.* 2nd ed. Philadelphia: W.B. Saunders and Co., 1977.

This detailed reference material is written for the college-level student.

Hardin, Garrett. *Birth Control.* A Biological Sciences Curriculum Study Book. New York: Pegasus, 1970.

This is a sourcebook on current methods of birth control and contraception.

Hart, Gavin. *Sexually Transmitted Diseases.* Burlington, North Carolina: Carolina Biological Supply Co., 1976.

This short reference book defines the broad spectrum of venereal diseases. It can be helpful as background material for the teacher.

Keller, Dolores Elaine. *Sex and the Single Cell.* New York: Pegasus, 1973.

This is a somewhat different approach to reproductive functions, nature's ends, and male—female issues.

Shepro, David; Belamarich, Frank; and Levy, Charles. *Human Anatomy and Physiology*. New York: Holt, Rinehart and Winston, Inc., 1974.

Chapters 18 through 21 present a college-level discussion of the endocrine system, female and male reproductive system, prenatal development, and birth in a clear and concise manner. The book has illustrations and pertinent discussions of clinical considerations.

Tanner, James M. "Growing Up." *Scientific American* 229 (September 1973): 35-44.

This article concerns the events that occur in the interaction between the environment and genetic potential during a child's growth. The events of the environment on growth are critical to the health of the adult.

Tanner, James M.; Taylor, Gordon Rattray; and the Editors of Time-Life Books. *Growth*. New York: Time, Inc., 1971.

Included in this book are a series of photographs of the human embryo and fetus (Chapters 2 and 3) and a discussion of reproductive hormones (Chapter 6).

Understanding Conception and Contraception. Raritan, New Jersey: Ortho Pharmaceutical Corporation, 1971.

This highly illustrated pamphlet includes discussions and diagrammatic views of the menstrual cycle, conception, pregnancy, and prenatal development.

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FOREWORD

Evidence has been mounting that something is missing from secondary science teaching. More and more, students are rejecting science courses and turning to subjects that they consider to be more practical or significant. Numerous high school science teachers have concluded that what they are now teaching is appropriate for only a limited number of their students.

As their concern has mounted, many science teachers have tried to find instructional materials that encompass more appropriate content and that allow them to work individually with students who have different needs and talents. For the most part, this search has been frustrating because presently such materials are difficult, if not impossible, to find.

The Individualized Science Instructional System (ISIS) project was organized to produce an alternative for those teachers who are dissatisfied with current secondary science textbooks. Consequently, the content of the ISIS materials is unconventional as is the individualized teaching method that is built into them. In contrast with many current science texts which aim to "cover science," ISIS has tried to be selective and to limit our coverage to the topics that we judge will be most useful to today's students.

Obviously the needs and problems of individual schools and students vary widely. To accommodate the differences, ISIS decided against producing tightly structured, pre-sequenced textbooks. Instead, we are generating short, self-contained modules that cover a wide range of topics. The modules can be clustered into many types of courses, and we hope that teachers and administrators will utilize this flexibility to tailor-make curricula that are responsive to local needs and conditions.

ISIS is a cooperative effort involving many individuals and agencies. More than 75 scientists and educators have helped to generate the materials, and hundreds of teachers and thousands of students have been involved in the project's nationwide testing program. All of the ISIS endeavors have been supported by generous grants from the National Science Foundation. We hope that ISIS users will conclude that these large investments of time, money, and effort have been worthwhile.

Ernest Burkman
ISIS Project
Tallahassee, Florida

CONTENTS PAGE

WHAT'S IT ALL ABOUT?

Many scientific details about human reproduction are still not known. But enough is known to describe and explain most steps in the formation of sperm and eggs, fertilization, and the prenatal development of a baby. This minicourse explains some of those important steps in human reproduction.

CORE

ACTIVITY 1: PLANNING

Activity 2 Page 4

Objective 2-1: Describe the location and the function of human testes and ovaries.

Sample Question: Match each body part with its function and its location.

Body Part	Function and Location
A. Ovary	1. usually releases sex cells one at a time
B. Testis	2. constantly produces sex cells
	3. located within the body cavity of an adult
	4. located outside the body cavity of an adult

Objective 2-2: Describe the structure and behavior of human sperm and eggs.

Sample Question: Match each sex cell with its behavior and its structure.

Sex Cell	Behavior and Structure
A. Sperm	1. can move by itself
B. Egg	2. cannot move by itself
	3. ball shaped
	4. has long tail

Activity 3 Page 8

Objective 3-1: Trace the path of a sperm from the organ in which it is produced to the structure in which it can fertilize an egg.

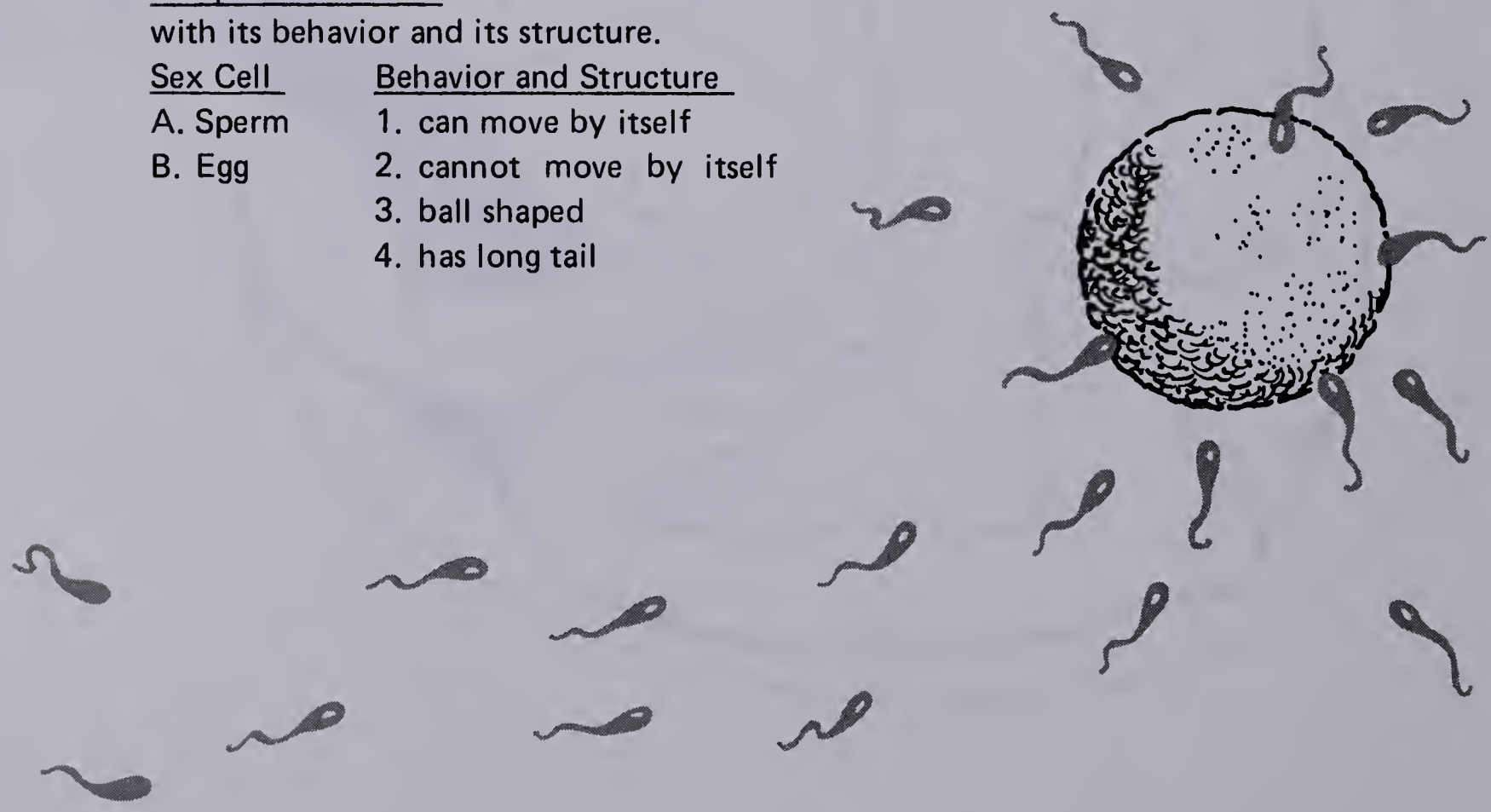
Sample Question: List the following organs in the order through which sperm pass to fertilize an egg.

A. Uterus
B. Vagina
C. Fallopian tubes

Objective 3-2: Trace the path of an egg from the organ in which it is released to the structure in which it can be fertilized.

Sample Question: List the following organs in the order through which an egg passes before fertilization.

A. Fallopian tubes
B. Body cavity
C. Ovary
D. Funnel-shaped opening



Activity 4 Page 12

Objective 4-1: Describe the main events in the development of a human embryo and fetus.

Sample Question: Which changes occur in a developing human being during the first two months of growth?

A. The fingers and toes form.
B. The fetus moves its arms and legs.
C. Fingernails and toenails begin to grow.
D. The eyes, ears, nose, and mouth form.

Activity 5 Page 18

Objective 5-1: Describe the location and the function of the uterus, placenta, umbilical cord, and fetal membranes in nourishing and producing a developing human being.

Sample Question: Match each structure with its location and its function.

Structure	Location and Function
A. Placenta	1. attached directly to embryo or fetus
B. Umbilical cord	2. in direct contact with uterus
	3. carries blood to fetus or embryo
	4. nutrients and wastes exchanged there

Activity 6 Page 23

Objective 6-1: Describe the sequence and timing of changes in the ovaries and uterus during the menstrual cycle.

Sample Question: Which event occurs at the same time as menstruation?

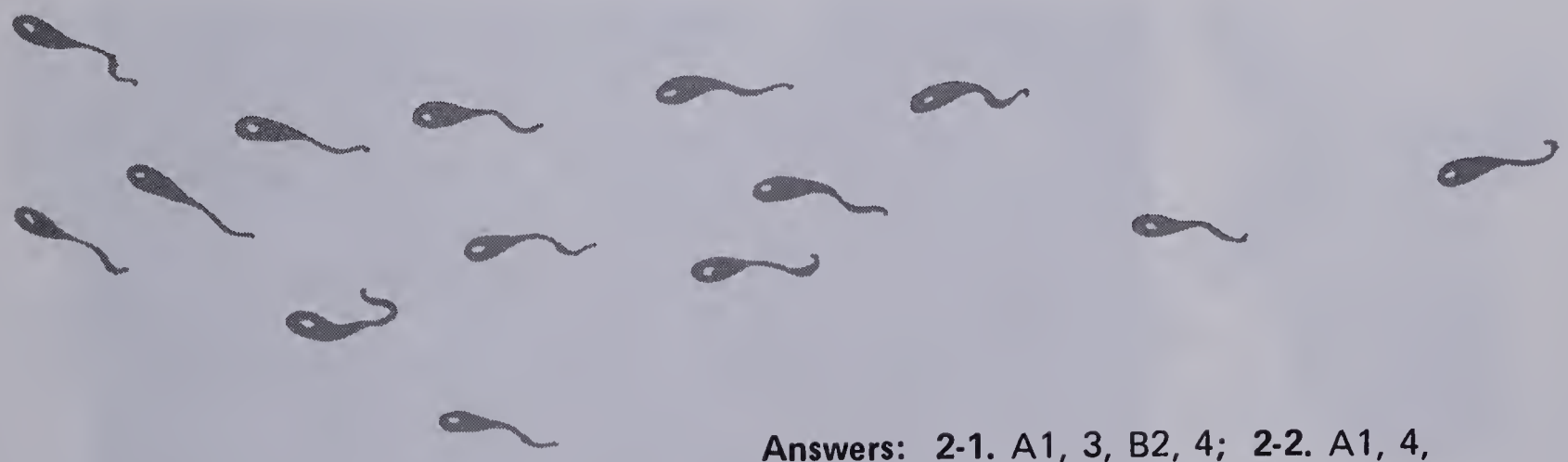
A. The lining of the uterus thickens.
B. An egg is released.
C. An egg can be fertilized.
D. A new egg begins to mature in an ovary.

Activity 7 Page 26

Objective 7-1: Explain how the menstrual cycle is under feedback control.

Sample Question: Why is it correct to say that the development or maturation and release of an egg are controlled by a feedback system?

A. Development or maturation and release of an egg occur because the hormone levels in the blood stay at the same level.
B. Development or maturation and release of an egg indirectly control themselves.
C. Eggs develop and are released in the ovaries at a continuous rate.
D. Eggs develop and are released without hormones.



Answers: **2-1.** A1, 3, B2, 4; **2-2.** A1, 4, B2, 3; **3-1.** B, A, C; **3-2.** C, B, D, A; **4-1.** A, D; **5-1.** A2, 4, B1, 3; **6-1.** D; **7-1.** B

ACTIVITY EMPHASIS: Sperm, the male sex cells, are produced in the testes. Eggs, the female sex cells, are produced in the ovaries. When a sperm penetrates an egg, the egg is fertilized.

MATERIALS PER STUDENT LAB GROUP: None

ACTIVITY 2: THE BEGINNING OF LIFE

Look carefully at Figure 2-1 below. It shows a male sex cell, called a *sperm*, entering a female sex cell, called an *egg*. The process is called *fertilization*. Some people consider the start of human life to be the moment of fertilization. This activity explains how and where sperm and eggs are produced.

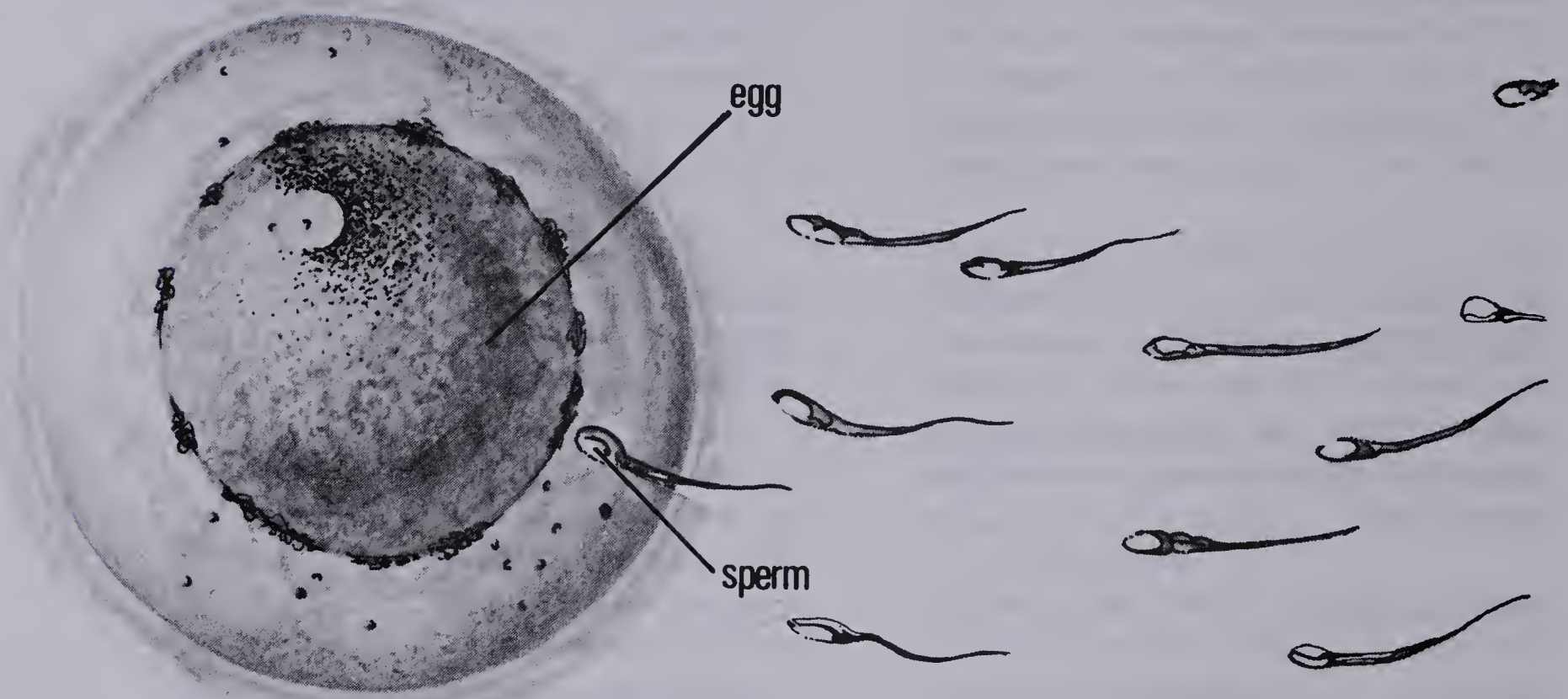


Figure 2-1

Figure 2-2 below is a photograph of three sperm taken through an electron microscope. The sperm are magnified two thousand times. Sperm are about 1/20 of a millimetre (0.05 mm) long – much too small to be seen without a microscope. About twenty-five hundred sperm could fit on the period that ends this sentence.

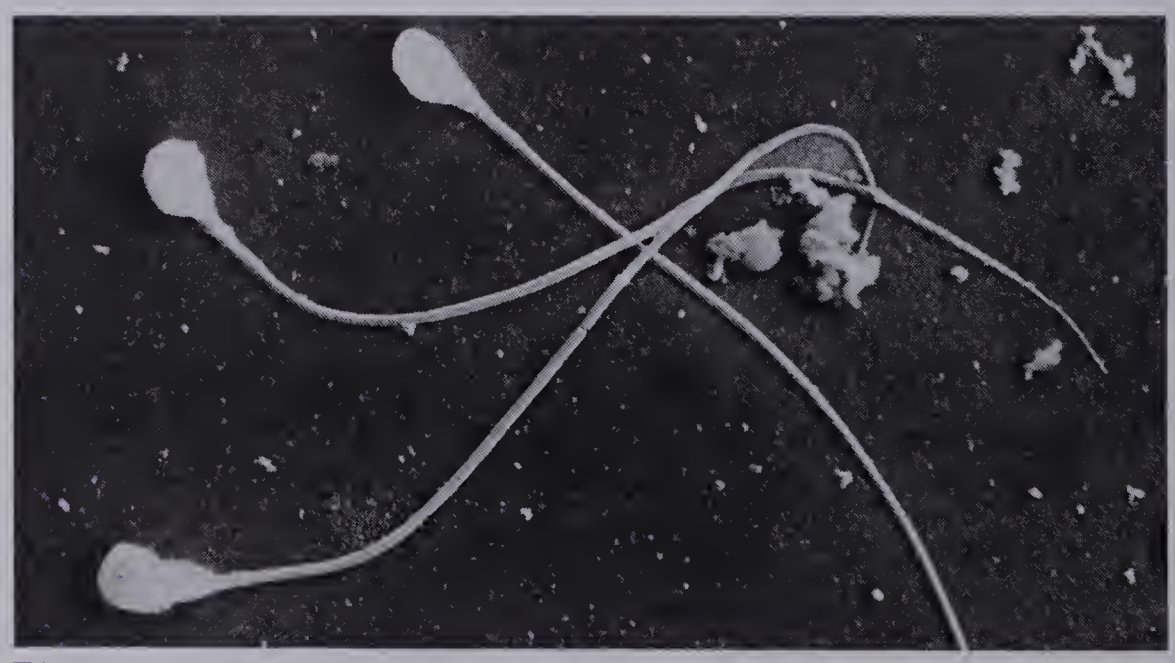


Figure 2-2

Each sperm has a bulb-shaped head as Figure 2-2 (page 4) shows. The head contains genetic information in chromosomes. The chromosomes determine certain characteristics of the baby, such as eye color, hair, and sex. Only twenty-three chromosomes are in the head of a sperm. That's half the number of chromosomes needed for a baby. The rest are in an egg. Scientists believe that the head of a sperm also contains a substance that helps the sperm puncture the surface of the egg.

Look at the long tails on the sperm in Figure 2-2 (page 4). When a sperm is active, it can move its tail back and forth and swim quite fast in body fluids. A sperm can move about four millimetres a minute.

Males continually produce millions of sperm, usually starting from about age eleven to fourteen and ending very late in life. Newly produced sperm are motionless. As they mature, they become capable of swimming through body fluids. From two hundred million to four hundred million sperm are released at a time. If the sperm end up in a female's body, some of them can swim to an egg. One may penetrate it, as you saw in Figure 2-1 (page 4).

☆ **2-1. Describe the structure and behavior of human sperm.**

2-1. Sperm have bulb-shaped heads and long tails. They are very tiny. Mature sperm can move themselves through body fluids at about 4 mm a minute.

Sperm are produced in two egg-shaped organs called *testes* [TES-teez]. One organ is called a *testis* [TES-tis]. Look at Figure 2-3 below. Until shortly before birth, a male's testes are inside his body cavity (Figure 2-3A). Before birth, the testes move down into a sac called the *scrotum* (Figure 2-3B). From then on, the testes hang outside of the body cavity (Figure 2-3C). Note that in Figure 2-3 only side views are shown. Only one of the two testes can be seen.

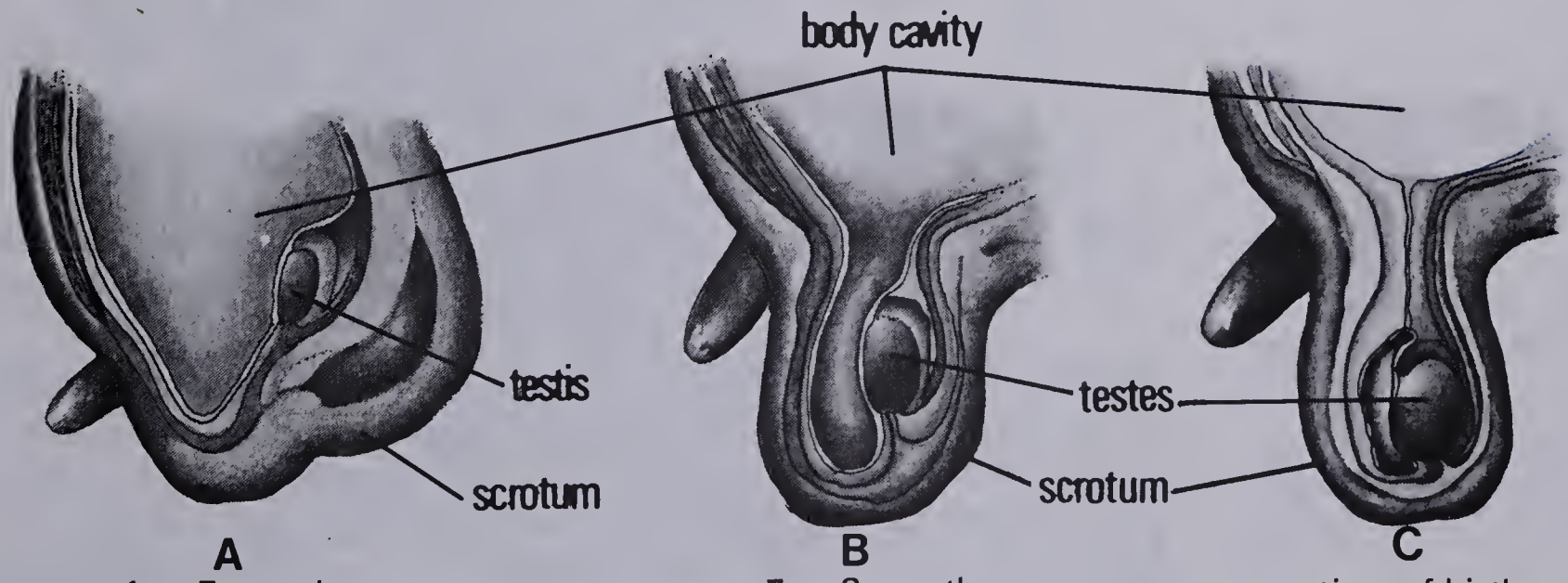


Figure 2-3

22-2. The human testes hang outside the body in the scrotum. They produce sperm continually from about age 11 to very late in life.

☆ **2-2. Describe the usual location and the function of the human testes after birth.**

Because of temperature control, the testes must be outside the body cavity. Internal body temperature is too hot for sperm production. Sperm can be produced only when the testes are about two degrees Celsius below body temperature, which is 37°C.

The temperature of the testes is controlled by the muscles of the scrotum and the muscles around the testes. The muscles contract and raise the testes closer to the body when the environmental temperature is low. The muscles relax and lower the testes when the environmental temperature is high.

2-3. If the environmental temperature is too cool, the testes are drawn up toward the body. If the temperature is too warm, the testes are lowered away from the body.

● 2-3. How does the body keep the temperature of the testes suitable for sperm production?

Figure 2-4 below shows a fully developed human egg as it looks through a microscope. It is magnified eight hundred times. An egg is 0.12 mm to 0.15 mm in diameter. It's much larger than a sperm. It can be seen even without a microscope. Notice that an egg is ball shaped. It is surrounded by a covering of cells.

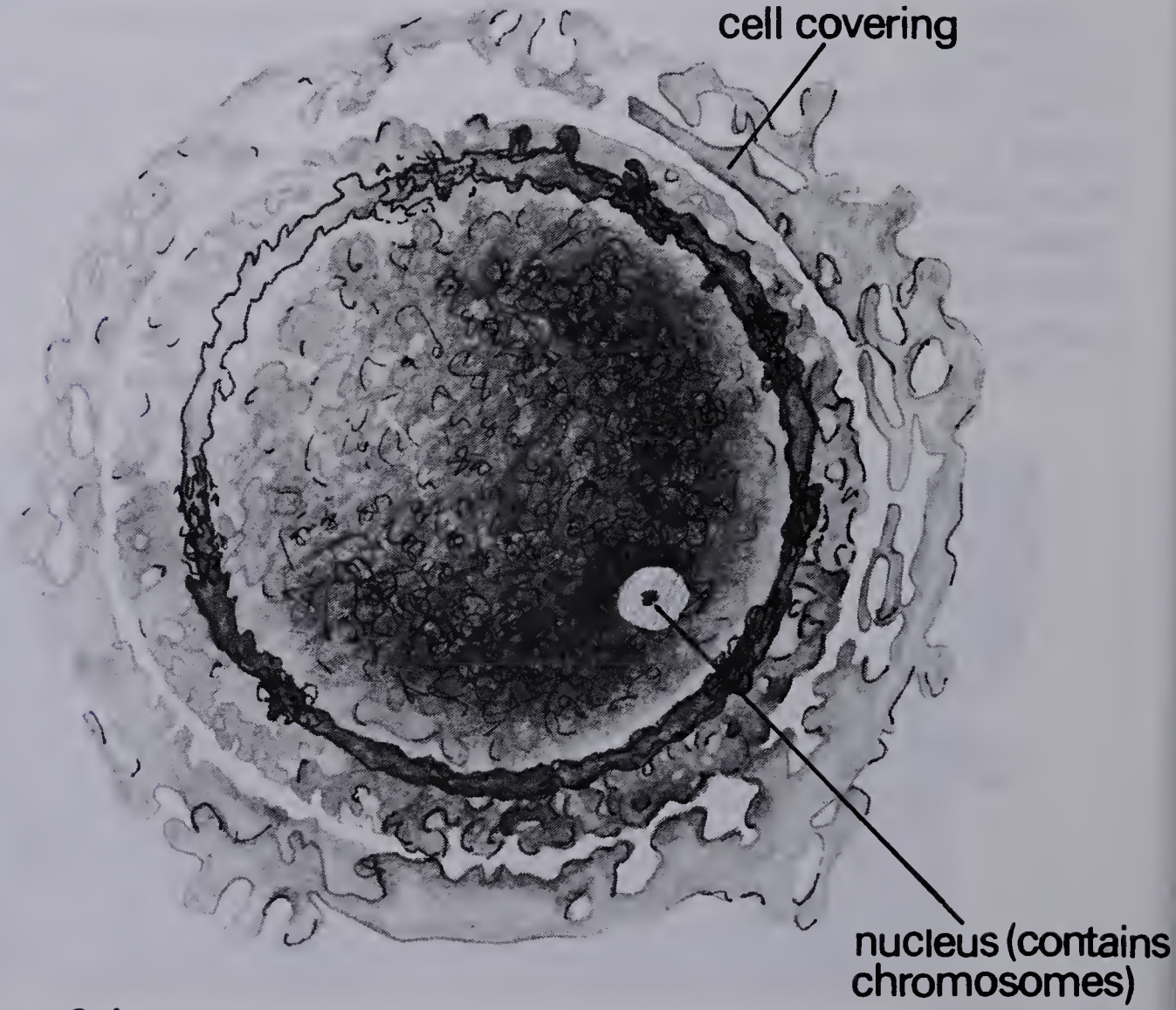


Figure 2-4

Inside an egg are twenty-three chromosomes. That's half the genetic information that is needed for a baby. The egg is carried by body fluids. It cannot move by propelling itself as a sperm can.

☆ **2-4. Describe the shape, size, and content of a human egg.**

2-4. A human egg is spherical, 0.12 mm to 0.15 mm in diameter, and contains 23 chromosomes.

Eggs are produced in females in two almond-shaped organs called *ovaries*. Each ovary is about 2.5 cm in length and 1.25 cm in diameter. The pair of ovaries is located inside the body cavity about 10 to 15 cm below the waistline. Look at Figure 2-5 below.

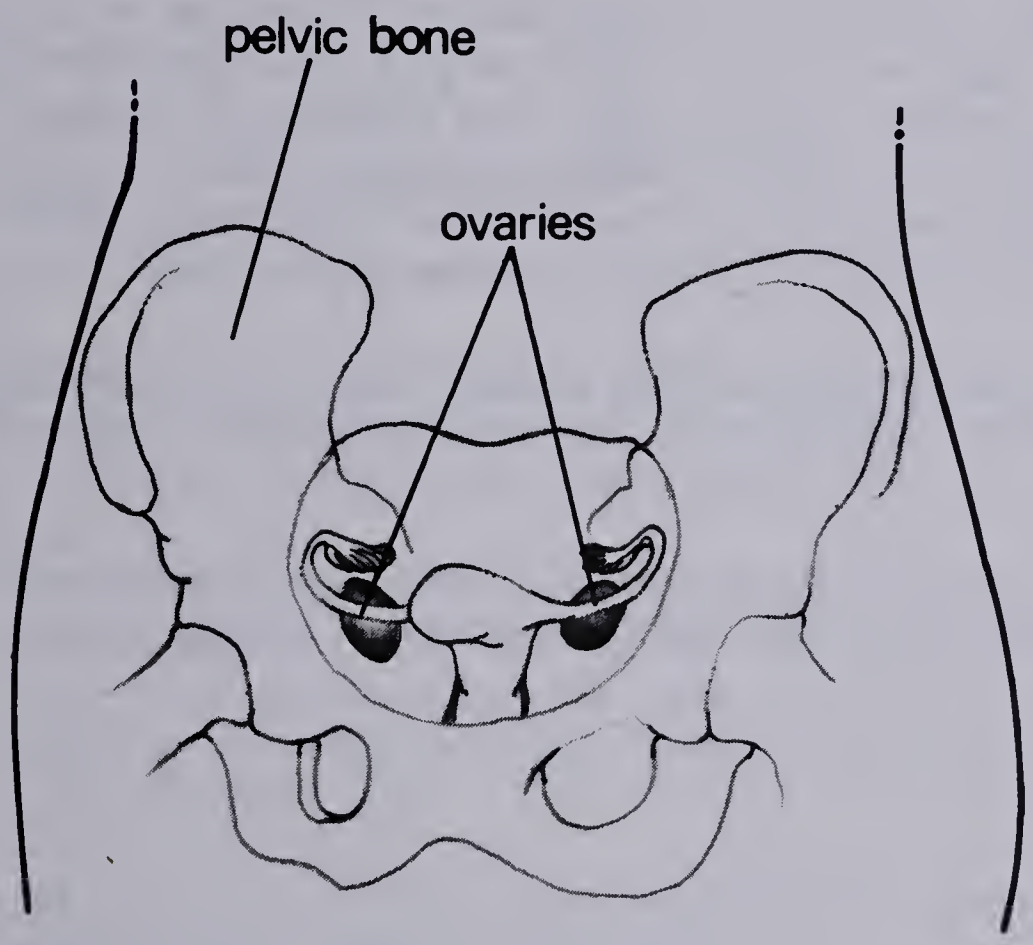


Figure 2-5

☆ **2-5. Describe the location and function of the ovaries.**

2-5. The ovaries are located inside the body cavity, 10 cm to 15 cm below the waistline. They produce eggs.

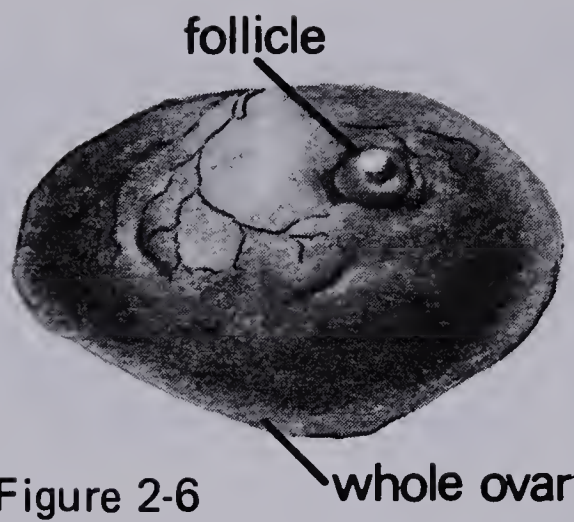
● 2-6. Why do you think the ovaries can be inside the body cavity, whereas the testes must be outside?

2-6. Egg production can go on at higher temperatures than sperm production can.

When a female is born, all of the eggs that she will ever produce are partly developed in her ovaries. Starting about age ten to fourteen, the eggs mature and are released, usually one at a time.

An egg develops in a follicle in the ovary. A follicle is a small ball of cells that enlarges and becomes filled with fluid. Figure 2-6 (page 8) shows a follicle as it increases in size and finally bursts, releasing the mature egg.

Ten to fourteen years old is an average, but many girls will begin menstruation earlier or later than that.



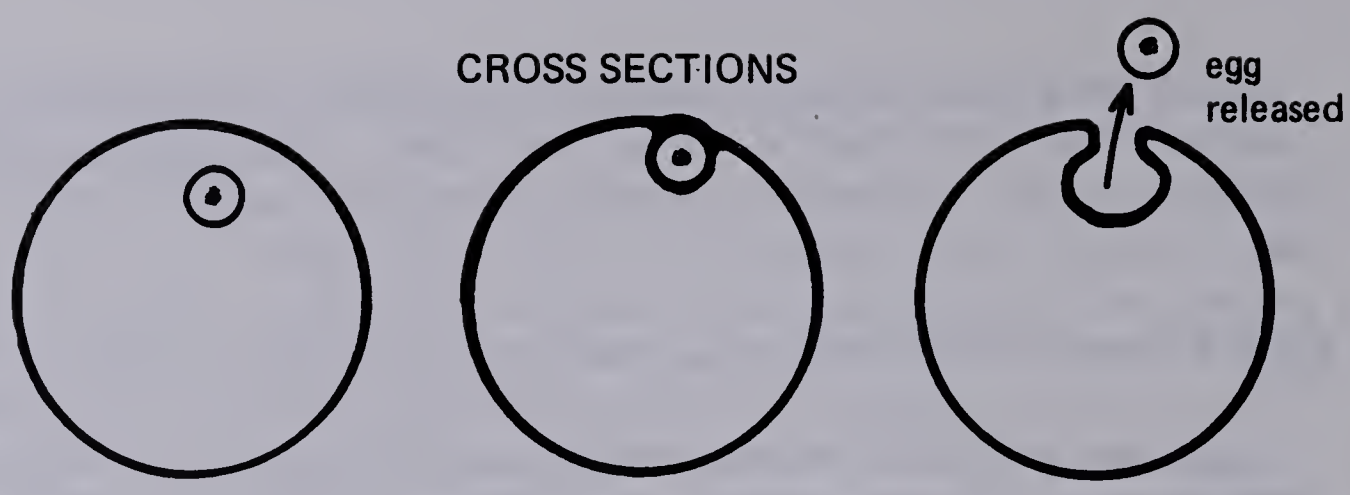


Figure 2-6

2-7. A human egg is released from the follicle of the ovary when the follicle bursts.

There is much conjecture about the number of eggs released in a year. Recent articles suggest that about twelve eggs released may be most common.

2-8. A woman produces about four hundred eggs in a lifetime. A man produces hundreds of billions of sperm in a lifetime.

2-9. Eggs develop one at a time, whereas sperm develop in large numbers. Egg development is a discontinuous process, whereas sperm production is continuous.

☆ **2-7. Describe how and where a human egg is released.**

The two ovaries in a female release an average of twelve or thirteen eggs each year. As few as nine or as many as eighteen may be released. The ovaries may alternate in releasing eggs. One or the other ovary releases an egg every twenty-eight days or so. The process goes on regularly until the female is about forty to fifty-five years old. Then egg release usually stops.

● 2-8. How does the number of eggs that a woman produces in her lifetime compare with the number of sperm produced by a man?

● 2-9. List at least two ways in which the development of a human egg differs from the development of a human sperm.

ACTIVITY EMPHASIS: Male and female sex organs transport the sex cells to the proper place for fertilization.

MATERIALS PER STUDENT LAB GROUP: None

ACTIVITY 3: TRANSFERRING SPERM AND EGGS

The key to human reproduction is fertilization. Fertilization is the process in which a male sex cell, called a *sperm*, enters the female sex cell, called an *egg*. The combined cell that results has everything needed to form a new human being.

But fertilization can't happen unless a sperm from a man's testes reaches an egg that has been produced by a woman's ovary. This activity explains how a sperm and an egg get together to produce a fertilized egg.

The structures in a male that are involved with producing and transferring sperm are shown in Figure 3-1 (page 9). The heavy lines show the structures that are outside the male's body.

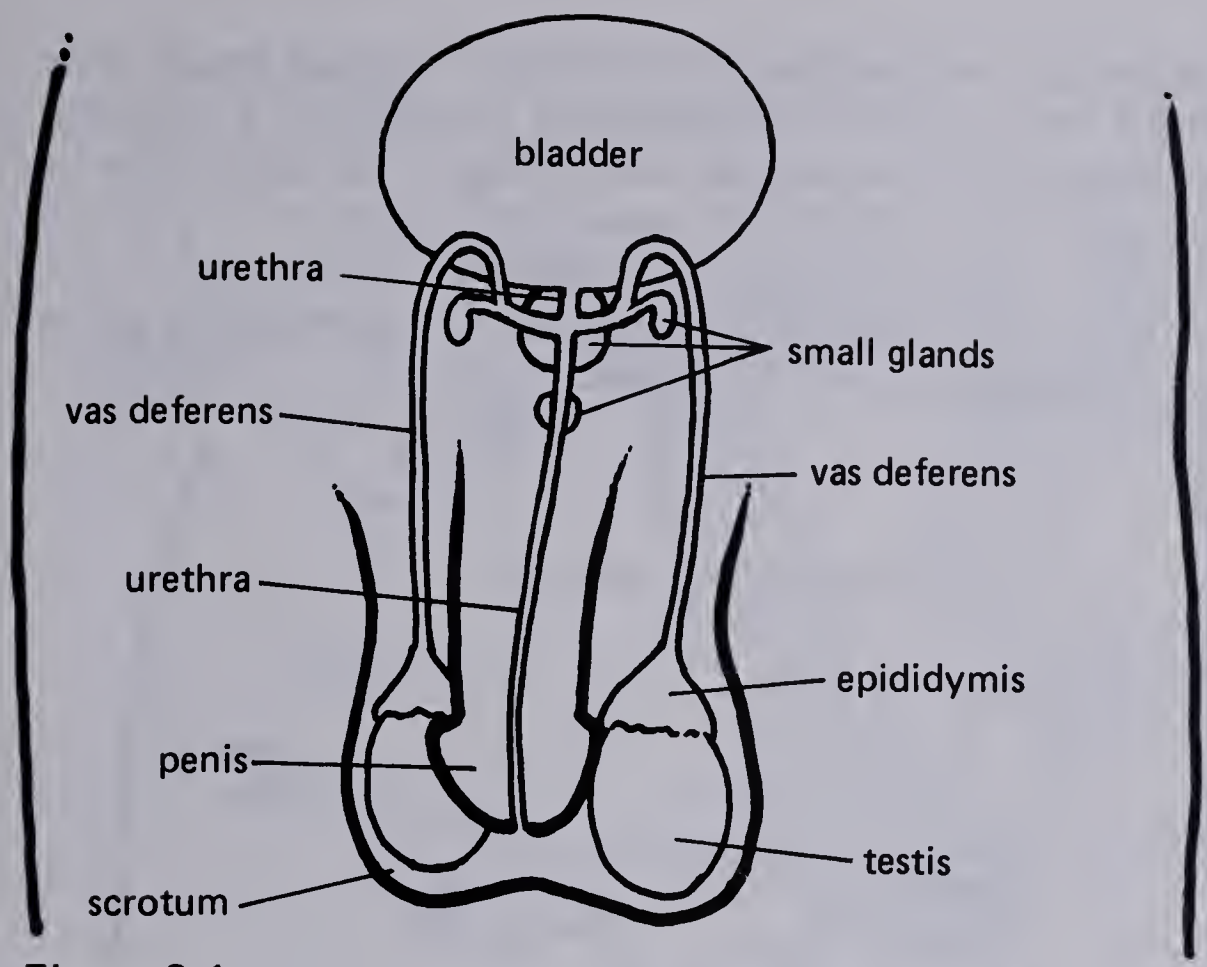


Figure 3-1

Before sperm can reach an egg, they must be released from a male's body. Starting at the testes where sperm are produced, follow the arrows in Figure 3-2 at the right. This is the path of the sperm.

After leaving the testes, sperm travel through the *vas deferens* [VAS DEF-a-renz]. Then they empty into the urethra [you-REE-thra]. The urethra is located inside the penis. It connects the bladder to the outside. Thus, in males, the urethra carries either urine or semen.

☆ **3-1. Name, in order, the tubes through which sperm pass on their way out of the body from the testes.**

In Figure 3-1 above, notice the areas labeled *small glands*. These glands discharge fluids into the vas deferens or the urethra. The whitish fluid from them mixes with the sperm.

The sperm plus the fluid are called *semen* [SEE-men]. The fluid provides a medium in which the sperm swim. It is also a source of nourishment for them.

● 3-2. What function do the fluids in the semen have?

Usually, sperm are stored in areas along the vas deferens before they are released. Sometimes, when the storage areas become full, sperm are released spontaneously. This sometimes happens during sleep in teenage males. It is perfectly normal.

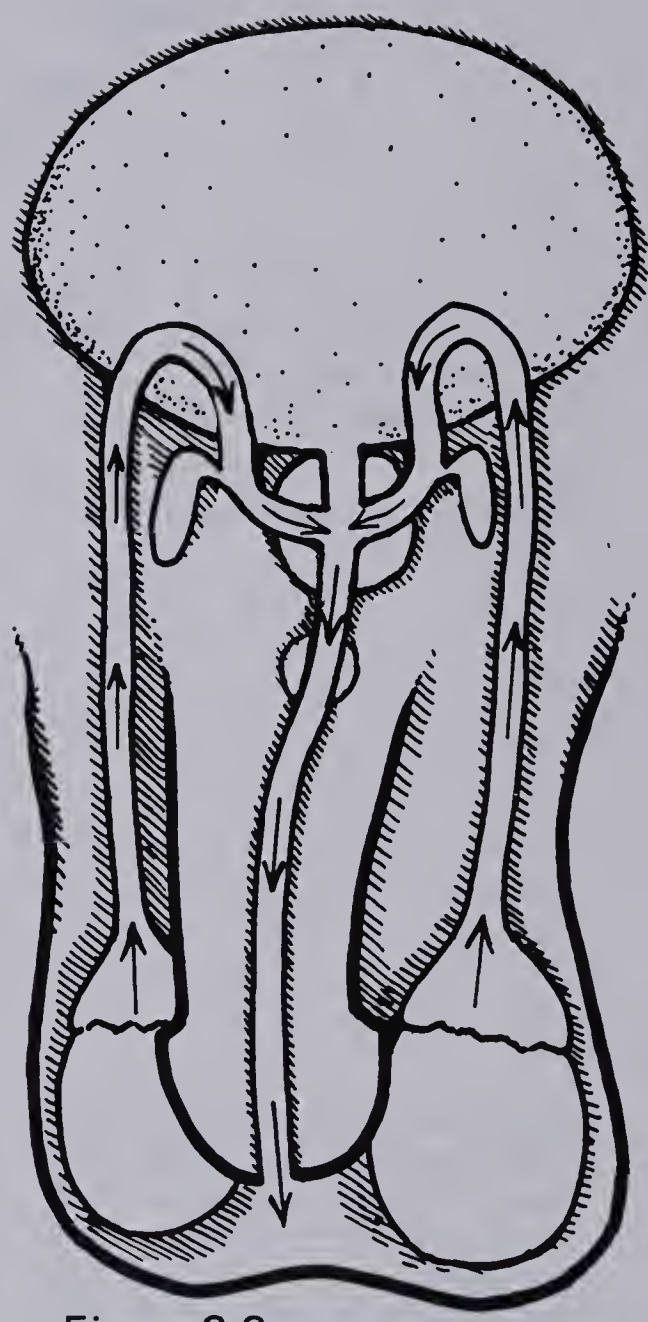


Figure 3-2

3-1. Vas deferens and urethra

3-2. They provide nourishment and a swimming medium.

During sexual activity, the penis stiffens. During sexual intercourse, the erect penis is placed inside the vagina, a muscular, tubular-shaped structure inside the female. The penis then releases three to four millilitres of semen containing from two hundred million to four hundred million sperm.

Figure 3-3 below shows the structures of a female that are involved with developing and transferring eggs.

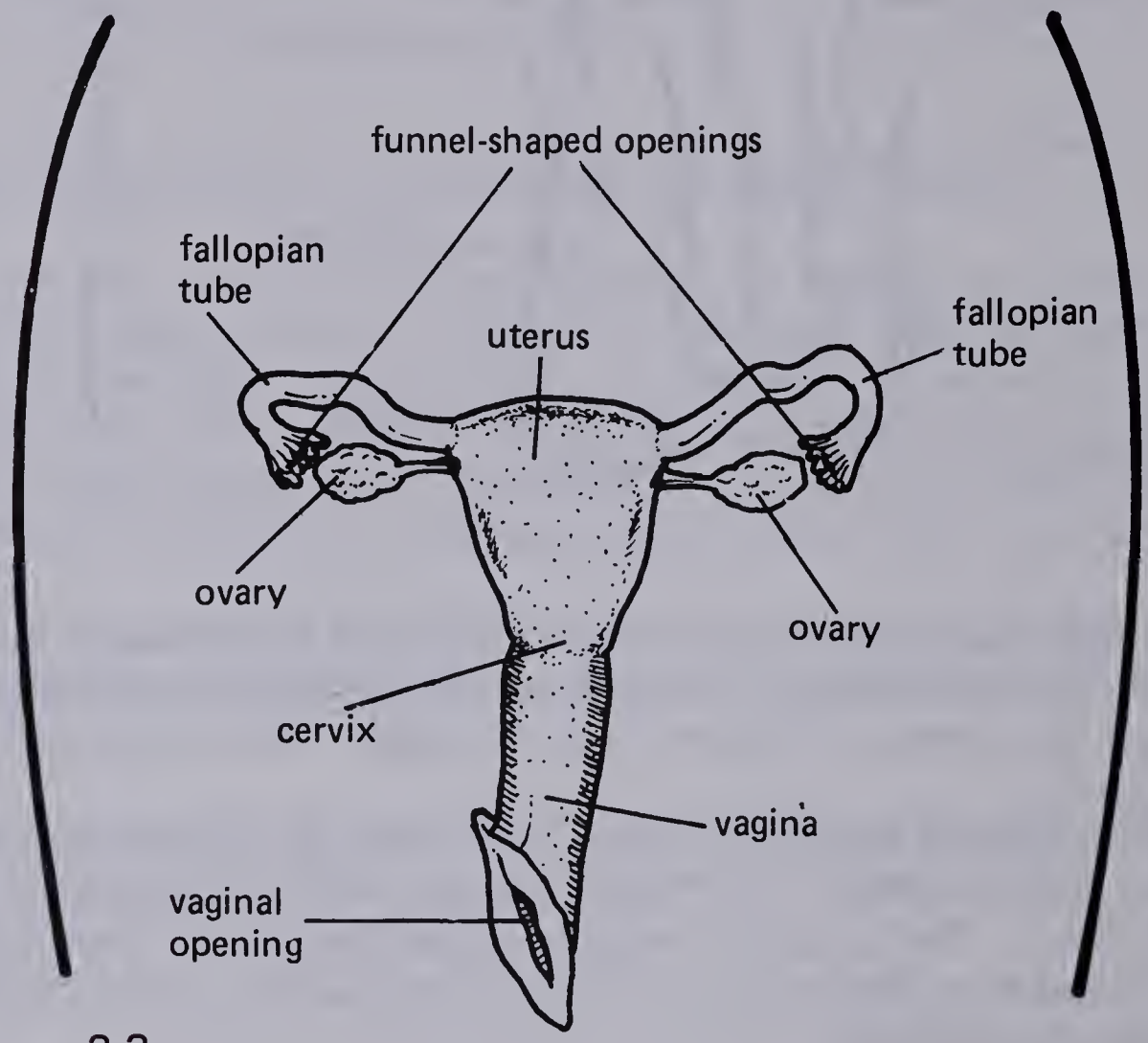


Figure 3-3

The penis releases the sperm into the upper part of the vagina toward the uterus (sometimes called *womb*). The uterus is a muscular, pear-shaped structure. Two fallopian tubes are connected to the uterus. The fallopian tubes carry the eggs. Underneath and near the fallopian tubes are the ovaries — the organs in which the eggs develop.

Look at Figure 3-4 (page 11). The arrows at the upper right side show the path of an egg after it is released from the ovary. Eggs are usually released from the ovaries about twelve or thirteen times a year.

Once released, an egg moves through the fluids of the body cavity toward the funnel-shaped opening of a fallopian tube. The opening is surrounded by fingerlike structures that move back and forth. This movement tends to direct the egg into the opening of the tube. From the opening, the egg starts moving through the tube toward the uterus.

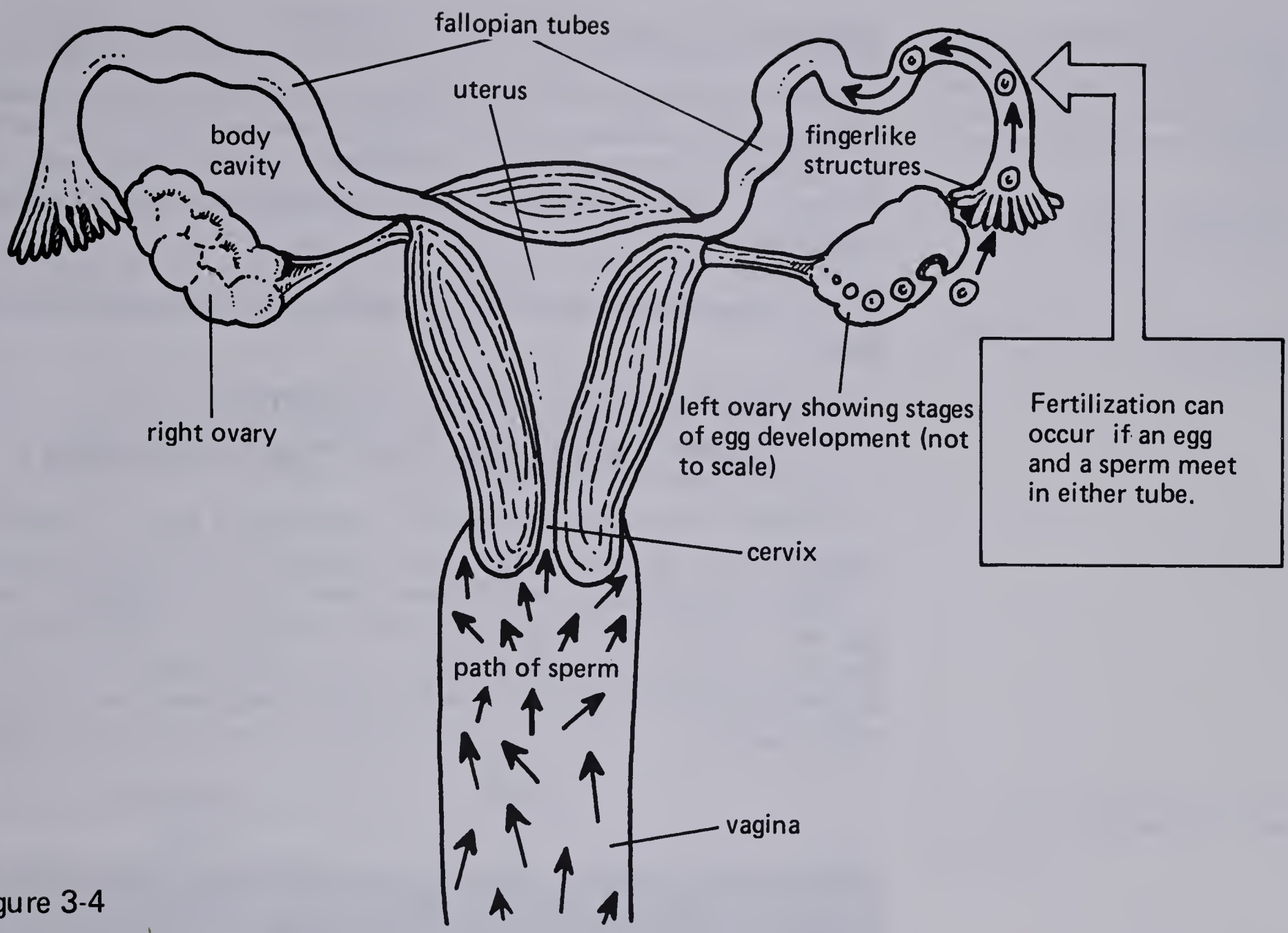


Figure 3-4

Now look at the lower part of Figure 3-4 above. When sperm are released into the vagina, they begin to swim in all directions. By chance, some sperm may swim through the cervix — the opening into the uterus. Many never find the opening. Some of the sperm that enter the uterus may move toward the upper end of the fallopian tubes. If the egg and sperm are in the same fallopian tube at the same time, fertilization can occur.

If fertilization does not occur, the egg lives only twenty-four to seventy-two hours. Sperm are capable of fertilizing an egg for only twelve to forty-eight hours.

Looking at Figure 3-4 above, you can see that the sperm swim through four structures and the egg moves through four structures before fertilization can occur.

Fertilization can occur in places other than the fallopian tubes, but, when that happens, it can be dangerous to the woman. If the embryo implants elsewhere than in the uterus, it will interfere with the woman's other body functions as it grows.

☆ **3-3. List, in order, the female structures that a sperm must travel through to fertilize an egg. Start with the vagina.**

3-3. Vagina, cervix, uterus, and fallopian tube

☆ **3-4. List, in order, the structures through which an egg moves before it is fertilized. Start with the ovary.**

3-4. Ovary, body cavity, funnel-shaped opening of fallopian tube, and fallopian tube

ACTIVITY EMPHASIS: The development of a human being begins with cell multiplication and is followed by the progressive formation of internal and external organs.

MATERIALS PER STUDENT LAB GROUP: None

ACTIVITY 4: A HUMAN BEING FORMS

Fertilization occurs when a sperm — a male sex cell — is united with an egg — a female sex cell. Fertilization begins the process of human development. In this activity, you'll learn about the events that occur between the time of fertilization and the time of birth.

● 4-1. What must happen to an egg for human development to begin?

4-1. It must be fertilized by a sperm cell.

THE FIRST TWO MONTHS: DEVELOPMENT OF THE EMBRYO

It takes thirty-two to thirty-six weeks for a baby to develop before birth. Most changes occur during the first eight weeks.

Figure 4-1 below shows a human sperm cell entering a human egg cell. Each cell contains half the materials, called *chromosomes*, needed for a new baby. Each cell has twenty-three chromosomes — twenty-two body chromosomes plus one sex chromosome.

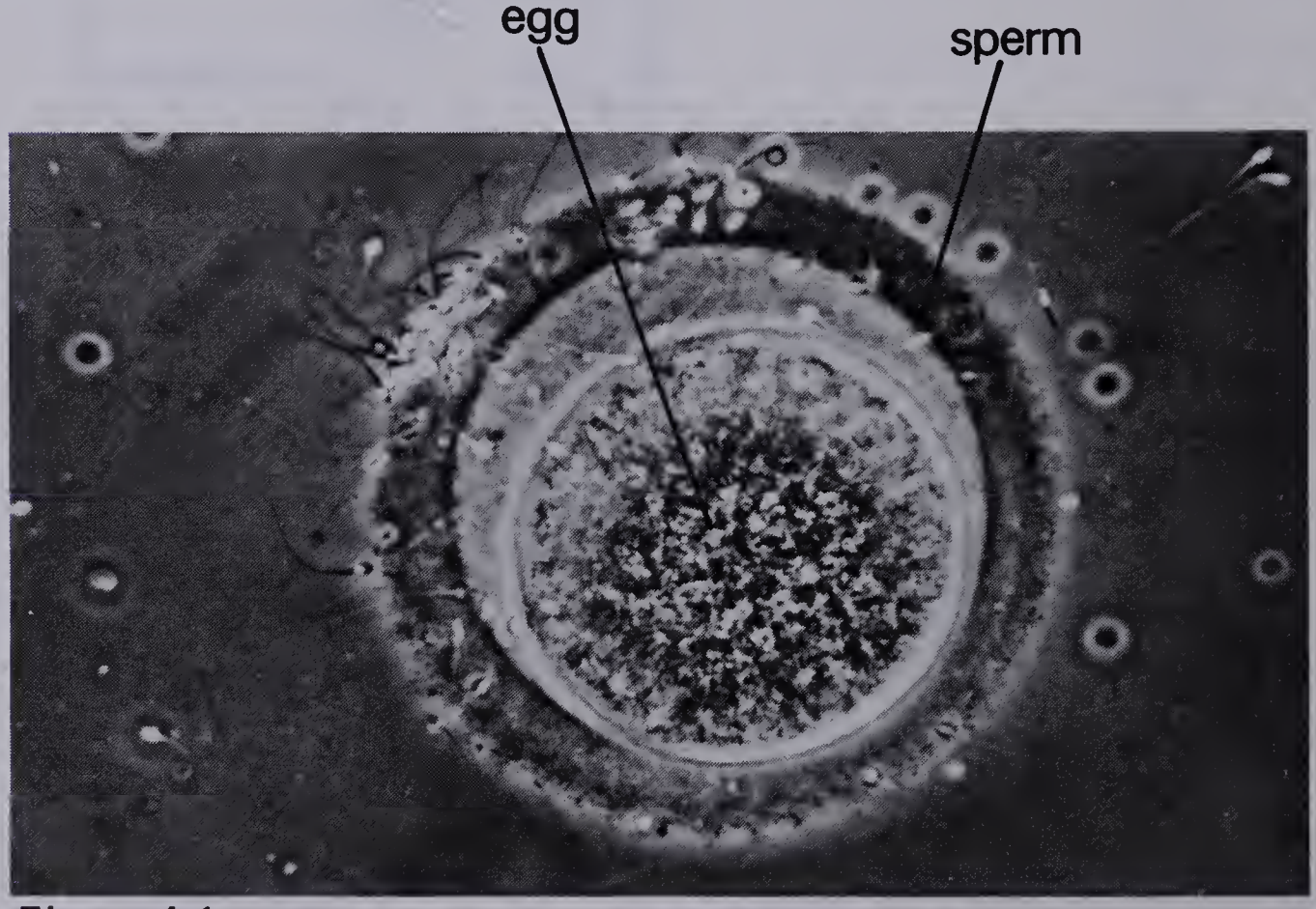


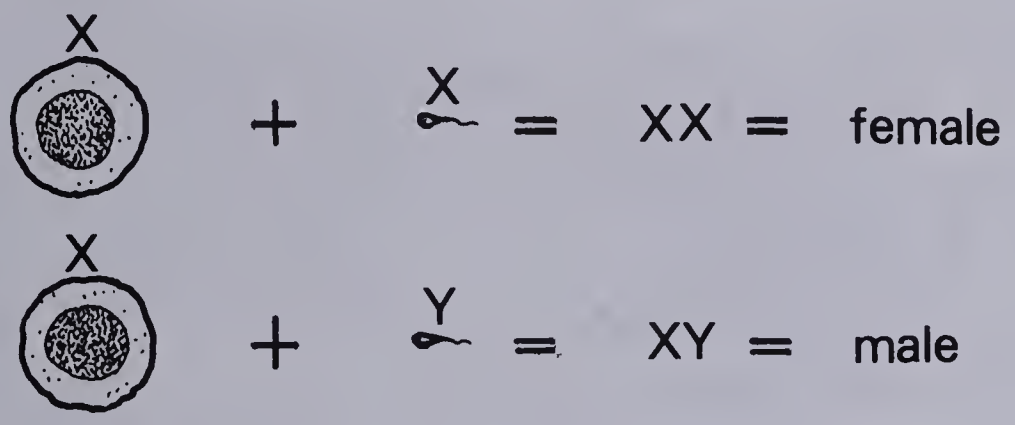
Figure 4-1

See "Background Information" in ATE front matter for notes about prenatal development.

The body chromosomes determine many characteristics of the new baby, such as eye and hair color. The sex chromosomes determine whether the new baby will be male or female. When the sperm cell and the egg cell unite, the resulting cell has forty-six chromosomes — all the material needed for a baby.

A normal egg cell has twenty-two body chromosomes plus an X sex chromosome. A normal sperm cell has twenty-two chromosomes plus an X or a Y sex chromosome. An egg cell with an X sex chromosome can be fertilized by a sperm cell with an X sex chromosome. The baby that develops will have XX sex chromosomes. It will be female.

An egg cell with an X sex chromosome can also be fertilized by a sperm cell with a Y sex chromosome. The baby that develops will have XY sex chromosomes. It will be male.



In either case, the baby will have two sex chromosomes plus forty-four body chromosomes in all.

● 4-2. How is the sex of a baby determined?

4-2. Sex is determined by the X or Y sex chromosome in the sperm cell.

Soon after fertilization, the fertilized egg cell divides, forming two cells. Each of the two cells divides, forming four cells, and so on. In this way, the embryo [EM-bree-oh] begins to grow. *Embryo* is the term used for a baby during the first two months of development before birth.

A two-week-old embryo is shown in Figure 4-2 below. The cells have formed a sphere. The spinal cord will eventually form from cells along the streak at the top of the sphere. Some cells have started to become different from others, forming different parts of the body.

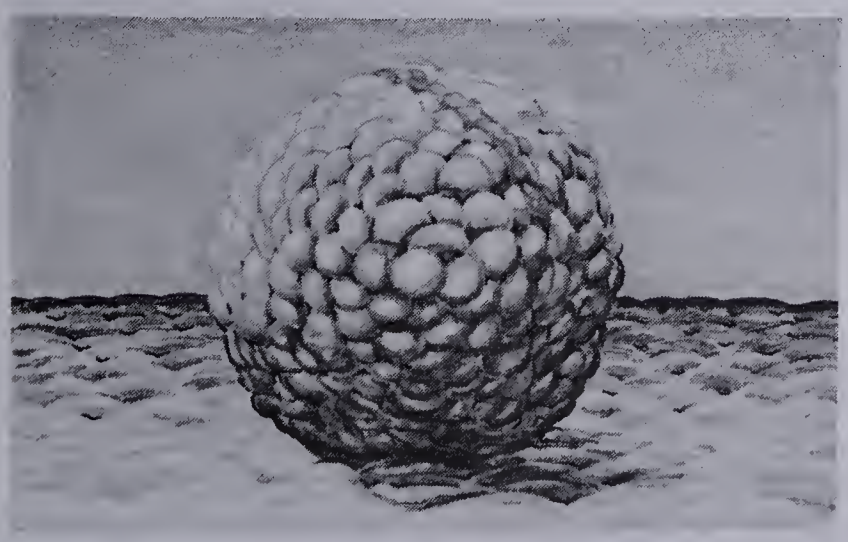


Figure 4-2

4-3. An embryo

● 4-3. During the first two months of development before birth, what is a developing human being called?

Figure 4-3 below shows a one-month-old embryo. Notice the tail, which will later disappear. Notice the head and the "buds" from which arms and legs will develop. The folds in the head will later become the mouth and ears. The heart and brain have been forming inside the embryo since the third week. They are the first organs to begin forming. By one month, the heart starts to beat.

Figure 4-3

4-4. At about one month

● 4-4. About what age does an embryo have arm and leg buds?

4-5. The heart and the brain

● 4-5. Which two organs are the first to begin forming inside the embryo?

Figure 4-4 (page 15) shows an embryo at six weeks of age. From four to six weeks of age, the eyes, ears, nose, and mouth of the embryo begin to form. Fingers and toes start to develop on the hands and feet. The embryo continues to grow in size. New features develop as the cells continue to divide and to become somewhat different from each other.

Figure 4-4

Figure 4-5 below shows a two-month-old embryo. The embryo has skin. The bones have started to form. Most of the organs, including the kidneys and stomach, are formed.

Figure 4-5

● 4-6. By what age are most of the organs present inside the embryo?

4-6. By two months

All the parts of the developing baby come from cells that divide and become different from each other. Scientists do not fully understand the process by which this happens.

THE LAST SEVEN MONTHS: DEVELOPMENT OF THE FETUS

Most of the features of a developing human being are present after two months. But most of the organs of a fetus must further develop before it can live outside of its mother. (*Fetus* is the term used for a baby during the last seven months of development before birth.) During the last seven months, the organs develop. The fetus greatly increases in size. The size increase occurs mostly during the eighth and ninth months.

During the third month of development, the eyelids of the fetus close and the outer ears are completely formed. By four months, the bones are well developed. The fetus can move quite a bit. The mother can feel this movement. A four-month-old fetus is shown in Figure 4-6 below.

Figure 4-6

Hair, eyelashes, and teeth form in the fetus by six months. Toenails and fingernails also develop about that time. Figure 4-7 below shows a six-month-old fetus.

Figure 4-7

From the seventh month until birth, there are few changes in the fetus. The fetus grows larger and chubbier. By the eighth month, all the internal organs of the fetus except its lungs can function separately from the mother. After nine months, the baby is ready for birth. Figure 4-8 below shows a newborn baby.

Figure 4-8

● 4-7. What is the main change in a fetus during the last two months of development?

4-7. An increase in size

● 4-8. When is a developing baby called a *fetus*?

4-8. After the second month of prenatal development

● 4-9. During which month can a pregnant woman usually begin to feel a fetus move?

4-9. During the fourth month

The exact times that features will appear in a particular embryo or fetus cannot be predicted. Individuals are not all alike. However, Figures 4-2 through 4-8, together with the accompanying descriptions, explain the events and the approximate times that they occur. Take a few minutes to go back over the activity. Then answer Question 4-10 below.

☆ **4-10. List the following events in the order in which they occur in a developing baby.**

A. Bones have started to form.
B. The fetus could live independently of its mother.
C. Heart and brain begin to form.
D. The fetus can move.
E. Eyes, ears, nose, and mouth start to form.
F. Teeth begin to form.

4-10. C, E, A, D, F, B

ACTIVITY EMPHASIS: Inside the uterus of the mother, a developing fetus is protected from shock and temperature change. It receives nourishment and oxygen and eliminates wastes through the placenta.

MATERIALS PER STUDENT LAB GROUP: None

ACTIVITY 5: LIFE BEFORE BIRTH

When astronauts leave their spaceships to walk in space, they are protected by space suits. The astronauts are connected by long cords to machines that control the air and temperature inside their suits. Look at Figure 5-1 below.

Figure 5-1

A baby developing inside its mother needs protection and nourishment. These are provided by structures similar to an astronaut's space suit. In this activity, you'll learn about those structures and their functions.

A developing baby is shown in Figure 5-2 (page 19). Compare the baby with the astronaut shown in Figure 5-1 above. Notice the four structures that help protect or nourish the baby. They are the wall of the uterus, the fetal membranes, the umbilical [um-BILL-ih-cal] cord, and the placenta [plah-SENT-ah]. The last three structures develop naturally around the baby as it develops in the uterus.

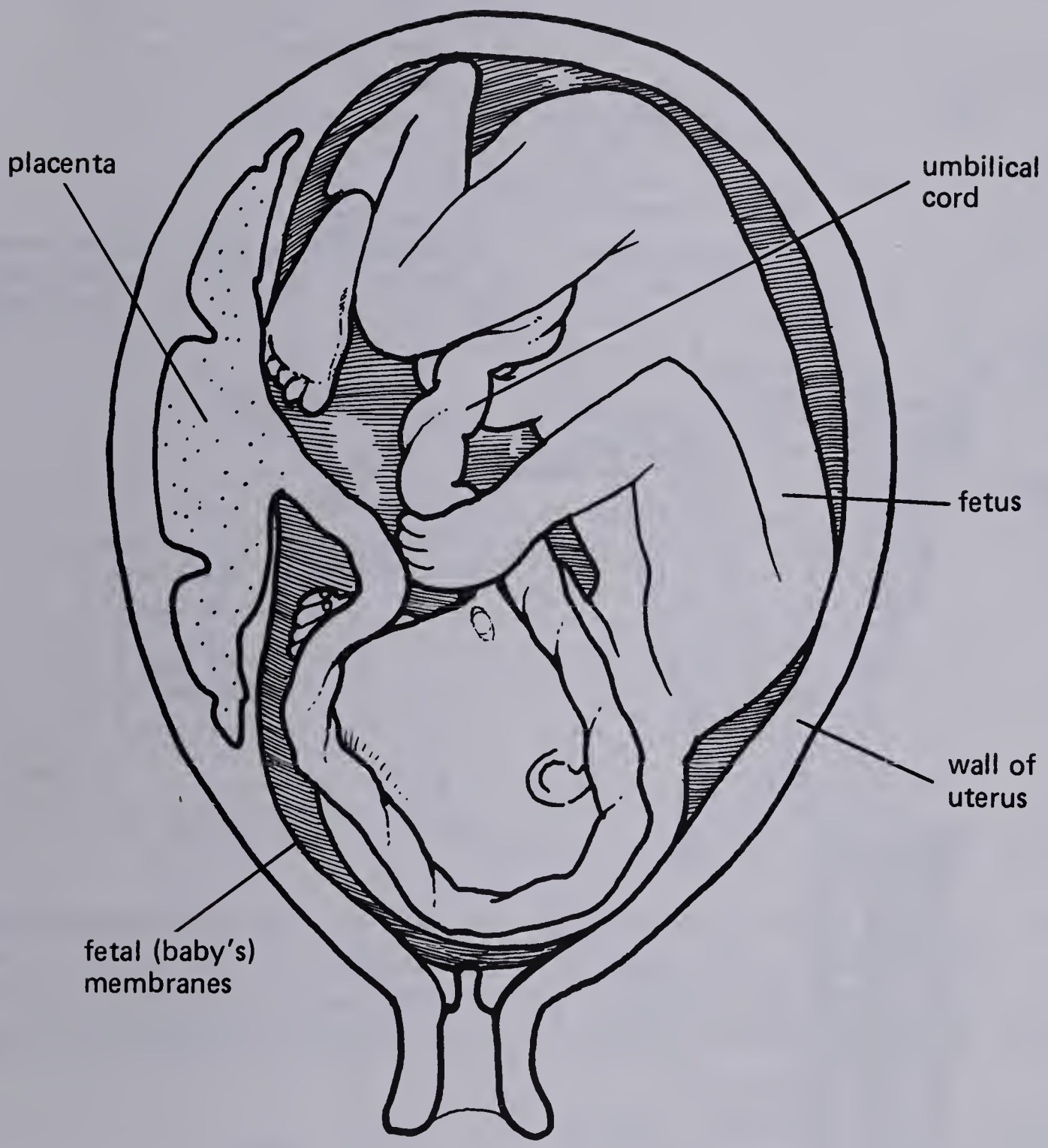


Figure 5-2

● 5-1. Which of the four structures surrounds the developing baby as a space suit surrounds an astronaut?

5-1. The fetal membranes

● 5-2. To what structure does the umbilical cord connect the baby?

5-2. The placenta

Human development begins with fertilization — when an egg (a female sex cell) and a sperm (a male sex cell) join. Fertilization normally occurs in one of the fallopian tubes of a female.

Look at Figure 5-3 (page 20). During the first few days of development, the embryo [EM-bree-oh], or developing baby, is just a ball of cells. The embryo is nourished by food material that was originally stored in the egg.

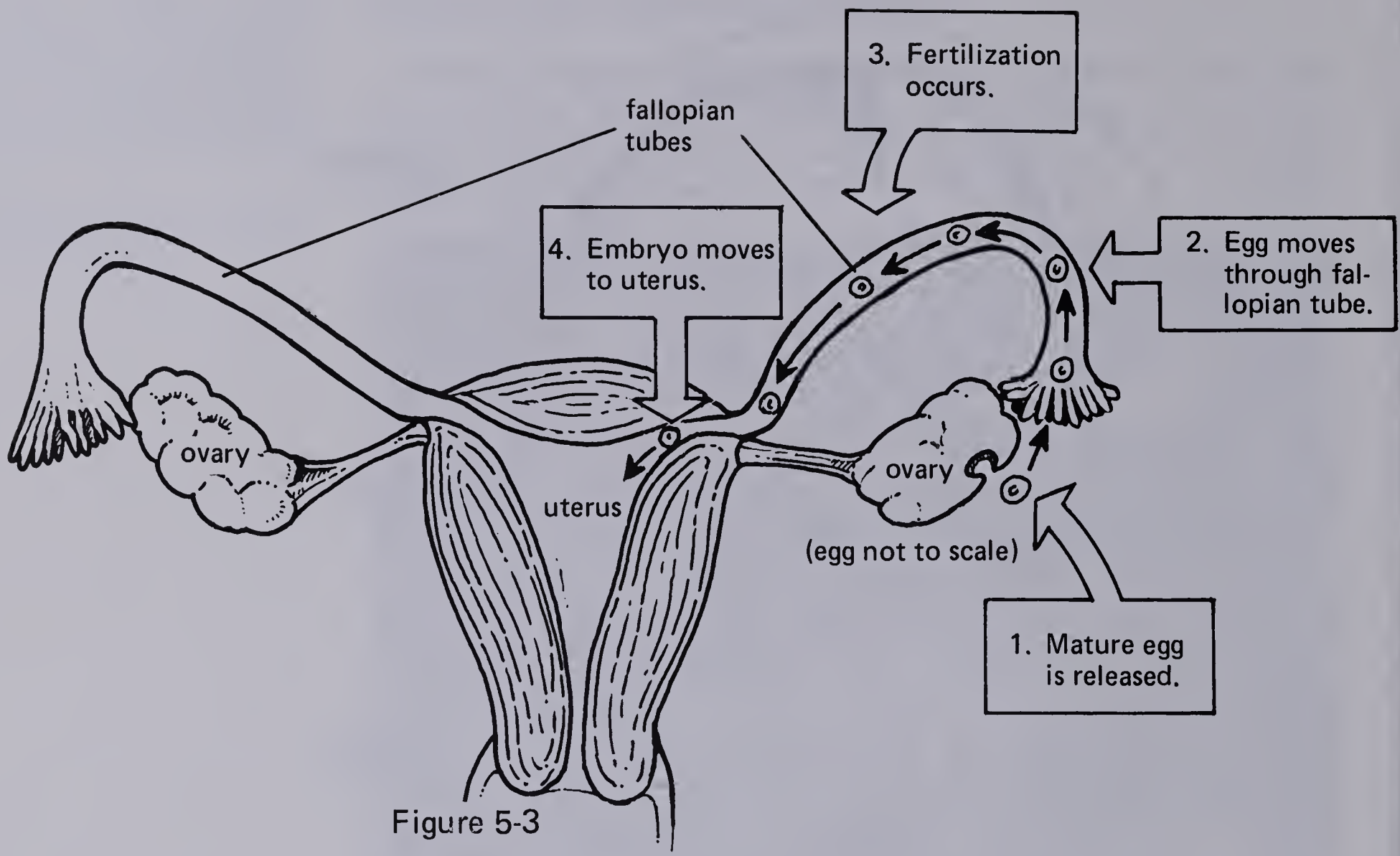


Figure 5-3

The embryo moves into the uterus. By a process called *implantation*, the embryo dissolves part of the lining of the uterus and sinks among the cells of the uterus. The embryo continues to develop. Figure 5-4 below shows an implanted embryo.

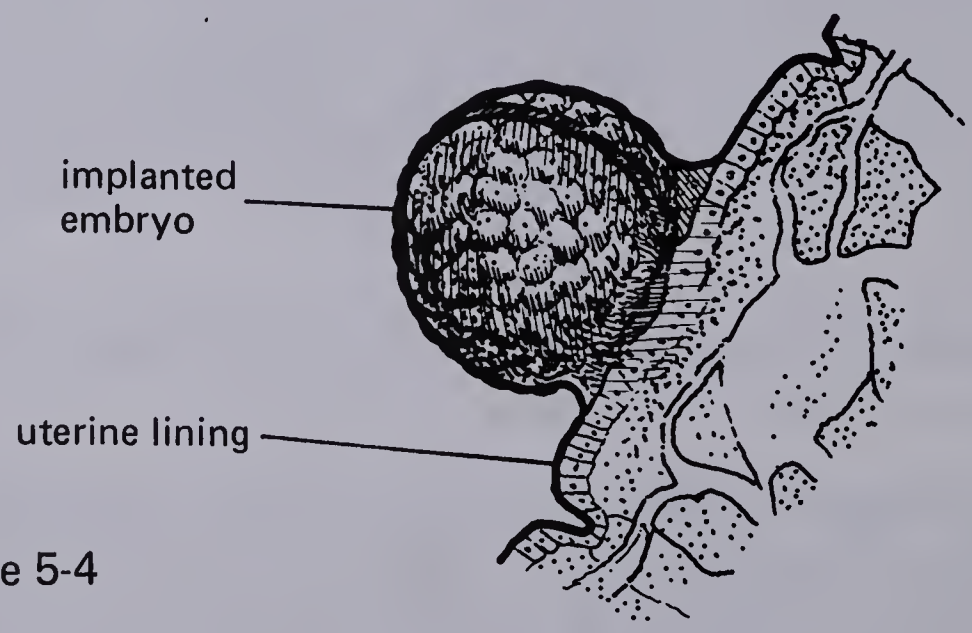


Figure 5-4

Figure 5-5 (page 21) describes how the developing baby lives. The numbers on the diagram match the numbered "Events" listed in the figure. Although separate events are listed, all six are going on at the same time.

Events

1. The mother's blood flows into spaces next to the projections of the placenta in the lining of the uterus.
2. The baby's blood flows through tiny blood vessels in the projections. It absorbs oxygen and other nutrients from the mother's blood.
3. The baby's blood, carrying oxygen and nutrients, returns to the baby through blood vessels in the umbilical cord.
4. The baby's blood absorbs waste materials from the baby. It flows back toward the placenta through blood vessels in the umbilical cord.
5. The baby's blood, carrying waste materials, enters tiny blood vessels in the projections of the placenta.
6. The mother's blood flows through spaces next to the projections. It absorbs the waste material and flows away from the lining of the uterus.

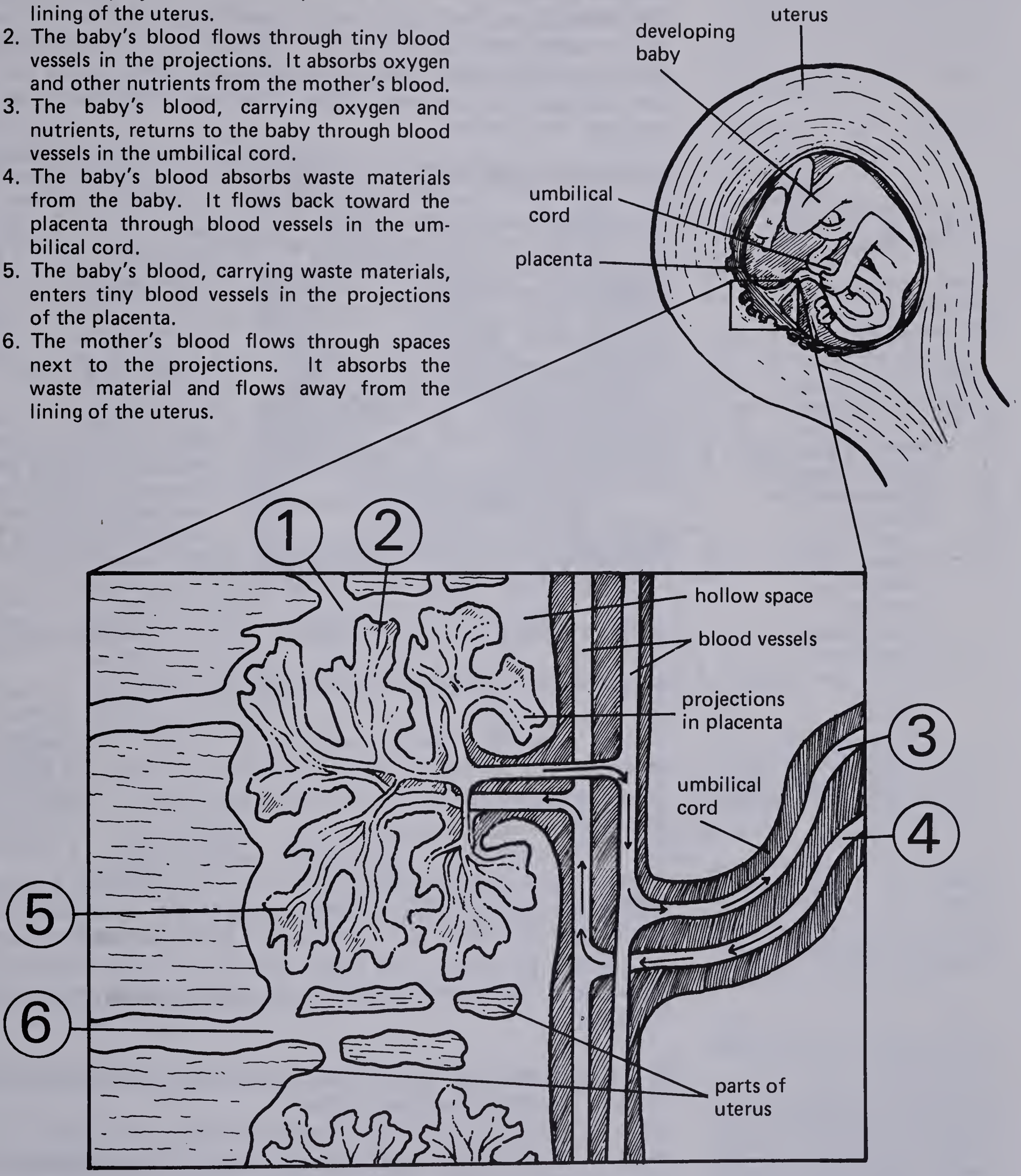
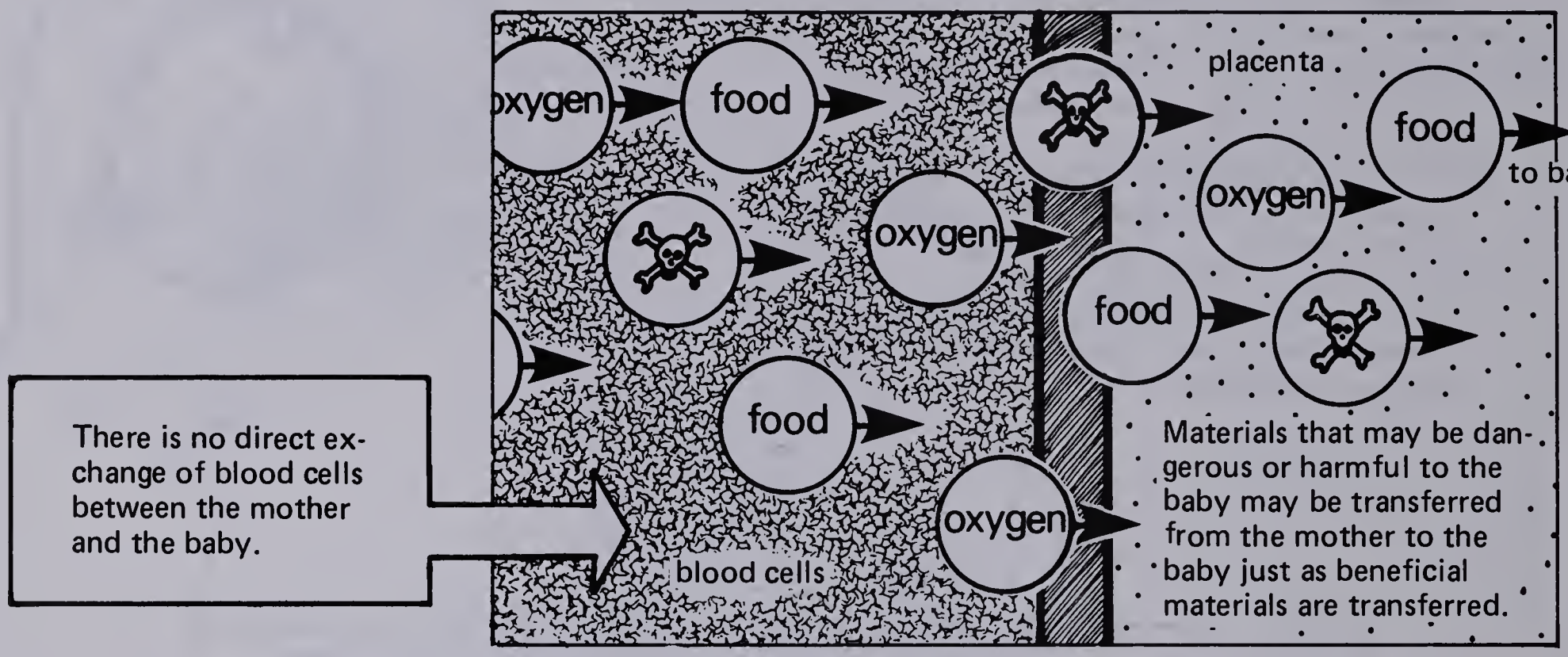


Figure 5-5

Materials, such as oxygen and nutrients, are present in the mother's blood. They are transferred from the mother through the placenta to the baby's blood. Likewise, carbon dioxide and other waste products are in the baby's blood. They are transferred from the baby through the placenta to the mother's blood for disposal. It is important to note two things about transfer through the placenta.



- 5-3. How does the placenta help in nourishing a growing baby?

5-3. The placenta provides a site for transfer of nutrients and oxygen and the baby's waste materials.

- 5-4. What is the function of the umbilical cord?

5-4. It brings the baby's blood close to the placenta where nutrients and oxygen can be absorbed and waste materials eliminated.

- 5-5. Once again consider astronauts in space. Do you think their method for getting oxygen and nutrients and for disposing of wastes is similar to that of a developing baby? Explain your answer.

5-5. [Answers will vary, but most students will probably say yes. There must be provisions for obtaining nutrients and disposing of wastes, although the exact methods differ.]

As a baby develops inside a uterus, it is protected from jolts and sudden temperature changes. The thick, muscular walls of the uterus and the fluids contained in the fetal membranes help to protect the baby from jolts. The body temperature within the uterus helps to protect the baby from sudden temperature changes.

☆ **5-6. In what two ways do the uterus and the fetal membranes help to protect a developing baby?**

5-6. They prevent jolts and rapid temperature changes.

- 5-7. Do you think an astronaut's suit protects an astronaut in a way similar to the way the uterus and fetal membranes protect a developing baby? Explain your answer.

5-7. [Answers will vary, but most students will probably say yes. There must be provisions for temperature and pressure changes, although the exact methods differ.]

ACTIVITY 6: THE MENSTRUAL CYCLE

ACTIVITY EMPHASIS: Between a woman's sexual maturity and menopause, the uterine lining thickens and is shed and an egg matures and is released in a cyclical pattern that averages twenty-eight days.

MATERIALS PER STUDENT LAB GROUP: None

In this activity, you'll read three newspaper articles. Use the information in each article to answer the questions that follow it. Be sure to study the illustrations in the articles. Begin with Figure 6-1 below, which will help you answer Questions 6-1 through 6-5.

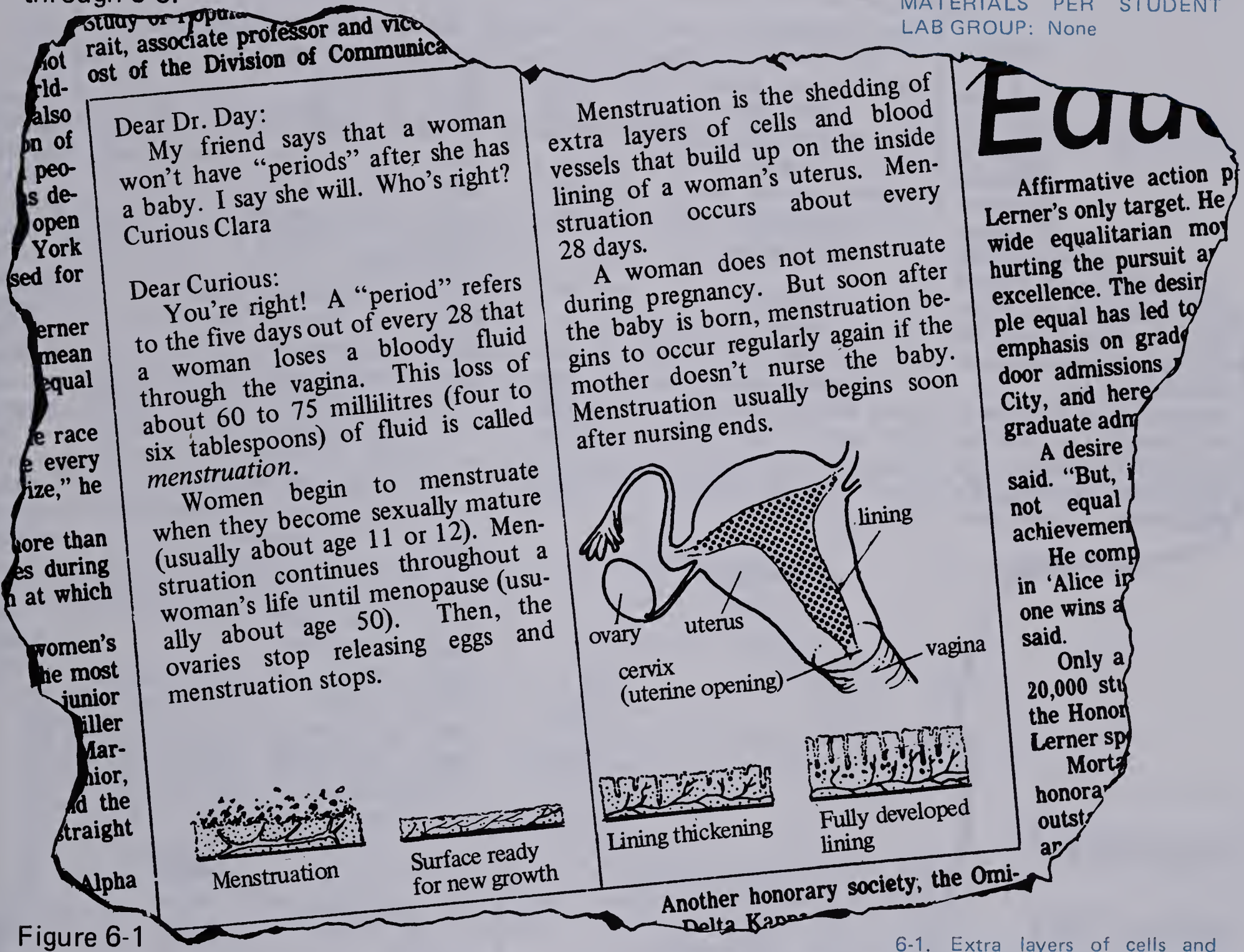


Figure 6-1

- 6-1. What materials are lost during menstruation? Where do these materials originate?

- 6-2. How often does menstruation occur?

- 6-3. Name three different times during a female's life when menstruation does not occur.

- 6-4. About how much fluid is lost during menstruation?

6-1. Extra layers of cells and blood vessels, which come from the inside lining of the uterus

6-2. About once every twenty-eight days

6-3. Before sexual maturity, during pregnancy, and after menopause; also during breast feeding, or nursing

6-4. About 60 to 75 ml (4 to 6 tablespoons)

6-5. The uterine lining thickens and then becomes thin.

● 6-5. How does the uterine lining change during the menstrual cycle?

Read the newspaper article in Figure 6-2 below. Then answer Questions 6-6 through 6-15.

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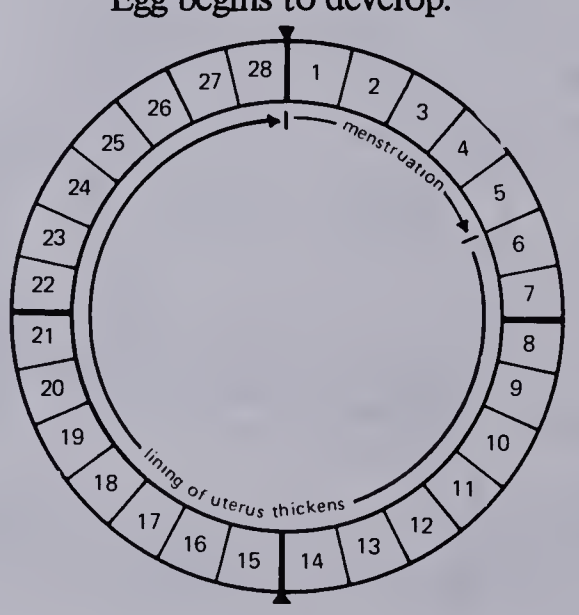
Dear Dr. Day:

My wife got pregnant for the first time in October three years ago. Now she's pregnant again. This time she got pregnant in June. What's going on here? I thought a woman could become pregnant only at a certain time of the year.
Surprised Husband

Dear Surprised:

Let me try to clear up the mystery for you.

Actually, a woman can get pregnant about 13 times a year during a few days of each menstrual cycle. Each cycle, from one menstruation to the next, is really the body's preparation for pregnancy.



Here is what happens during each cycle. I'll use a 28-day cycle for my explanation.

Day 1: If an egg has not been fertilized, the lining of the uterus begins to shed. This is the start of menstruation. At the same time, a new cycle is beginning because a new egg is maturing in one of the two ovaries.

Day 5: Menstruation stops.

Day 6: The lining of the uterus begins to thicken again.

Day 14: A new egg is released from the ovary. If it is joined within three days by a sperm, a baby begins to develop. The uterine lining will remain thick and will nourish the developing baby for nine months.

Day 28: If fertilization has not occurred, the blood vessels begin constricting and cutting off the nourishment to the lining. This causes the lining to break away.

Day 1: Usually the egg has not been fertilized. In that case the shedding of the uterine lining begins again. Meanwhile, another egg is maturing and a new cycle begins.

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Figure 6-2

6-6. Menstruation begins, and a new egg starts to mature in an ovary.

● 6-6. On Day 1 of a menstrual cycle, what two events occur?

6-7. Day 5

● 6-7. In a twenty-eight-day cycle, on what day does menstruation stop?

6-8. The uterine lining thickens.

● 6-8. What happens in the cycle after menstruation stops?

☆ **6-9. In a twenty-eight-day cycle, during what days does the uterine lining continue to thicken? For how many days does the lining thicken?**

6-9. From Day 6 to Day 28; a total of twenty-three days

● 6-10. In a twenty-eight-day cycle, when is a new egg released from an ovary?

6-10. Day 14

● 6-11. For fertilization to occur, within how many days after the egg is released must the egg be joined by a sperm?

6-11. Three days

● 6-12. If fertilization does not occur, what happens on Day 1 as the cycle repeats?

6-12. Menstruation begins, and a new egg starts to mature in an ovary.

☆ **6-13. Suppose menstruation begins on August 1 for a woman with a normal, regular, twenty-eight-day cycle. On what date might an egg be released from one of her ovaries?**

6-13. August 14

● 6-14. Suppose menstruation begins on November 12 for a woman with a normal, regular, twenty-eight-day cycle. On what date might an egg be released from one of her ovaries?

6-14. November 25

● 6-15. When an egg is fertilized, what is the function of the thickened uterine lining?

6-15. To nourish the developing baby

Read the newspaper article in Figure 6-3 below. Then answer Questions 6-16 through 6-18.

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Dear Dr. Day:

Your answers to Curious Clara seemed a little incomplete.

First, isn't it true that not all girls become sexually mature at age 11 or 12? Some girls first menstruate as young as nine or as old as 18. I believe that such girls are still considered normal.

The same is true with menopause. Menstruation can stop anytime between ages 40 and 55.

Normal menstruation can last anywhere from two to eight days. Isn't that true? And menstrual cycles can occur every 20 to 36 days. So 28 days is not a magical number. Am I right?

Smart Sue

Dear Smart:

You're exactly right! Once a woman's menstrual cycle begins, it is usually regular, even though it may differ from other women's cycles.

Even regular menstrual cycles can change, however. Physical stress, such as illness or overwork, and mental stress, such as tension and emotional strain, can cause irregularities in a woman's cycle.

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Figure 6-3

6-16. Irregularities are common. Worry itself may be the cause of those changes. Stress (physical or mental) and malnutrition are other causes.

6-17. Anywhere from 20 to 36 days, with 28 days as an average; anywhere from 2 to 8 days, with 5 days as an average

6-18. Physical or mental stress, pregnancy, breast feeding, menopause

● 6-16. A young woman knows she is not pregnant. And she is seemingly healthy. But she is upset about irregularities in her menstrual cycle. She feels that the irregularities are a sign of illness. What might a doctor tell this woman?

● 6-17. What is the range of days for a normal menstrual cycle? What is the range of days for normal menstruation?

● 6-18. Name at least two things that could cause a change in a woman's normal menstrual cycle.

ACTIVITY EMPHASIS: The interrelationship of the four hormones of the menstrual cycle (FSH, LH, estrogen, and progesterone) is an example of a feedback-control system.

MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter.

ACTIVITY 7: CYCLES AND FEEDBACK

A female's ovaries and uterus are constantly changing during the menstrual cycle. The changes occur in the following order:

1. The uterine wall thickens as an egg — a female sex cell — is released from one of the two ovaries.
2. If a sperm — a male sex cell — does not enter the egg, the egg is not fertilized. Then the uterine wall sheds its excess tissue and becomes thin again.

This process is called the *menstrual* [MEN-strul] *cycle*. It repeats about every twenty-eight days for thirty to forty years.

Let's consider what controls the sequence of events in a menstrual cycle. You'll see how the body "knows" when to release an egg or to thicken the lining of the uterus.

Scientists have learned that there are certain body structures called *endocrine glands*. These glands secrete — produce — special chemicals called *hormones*. Hormones are released into the blood and act as messengers that regulate or control many body functions. Figure 7-1 below shows a cross section of an endocrine gland.

Cells in the endocrine gland produce hormones. The hormones are secreted directly into the bloodstream and are carried to other parts of the body.

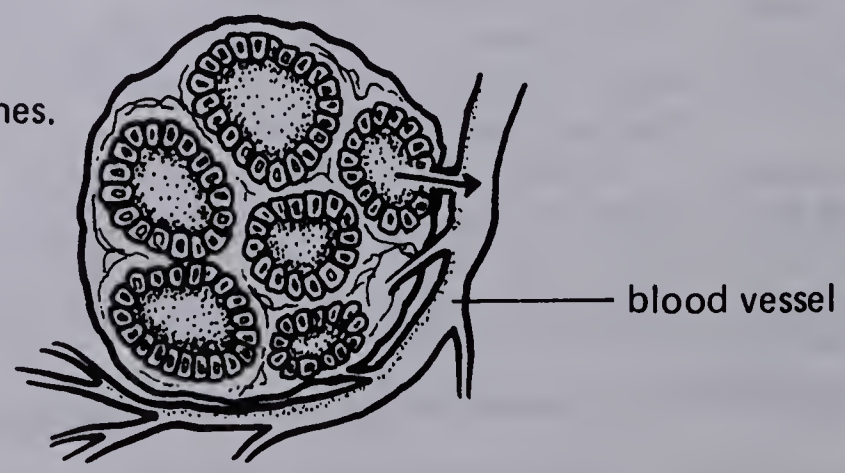
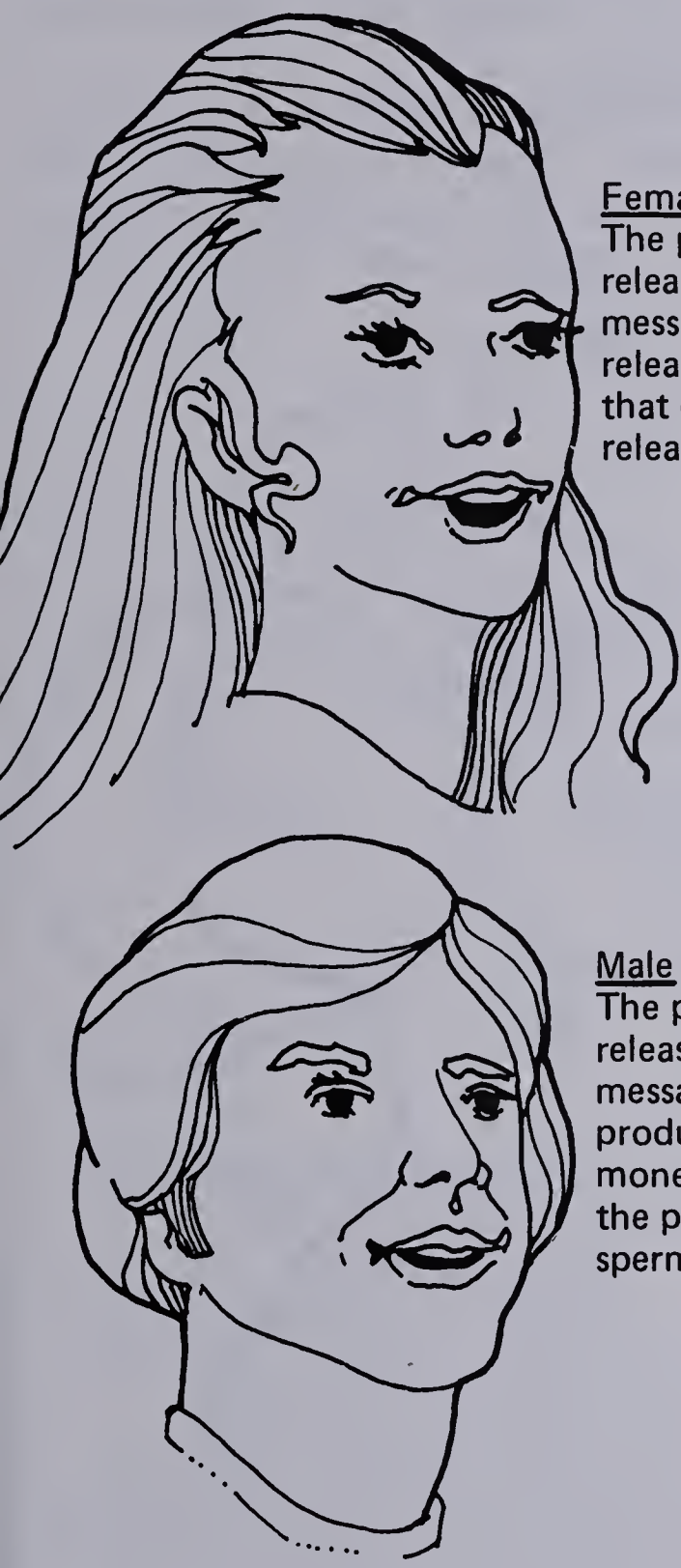


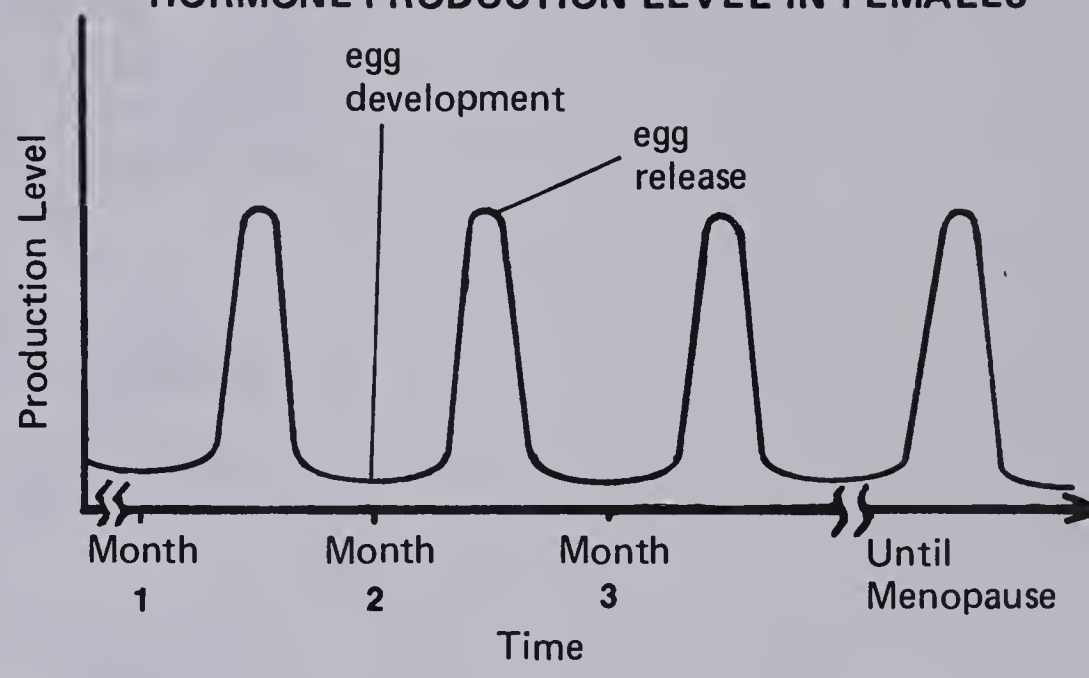
Figure 7-1

One endocrine gland is called the *pituitary gland*. It is near the brain. (See Figure 7-3, page 28.) The pituitary gland secretes hormones that cause ovaries to release eggs and testes to produce sperm.

Figure 7-2 below shows the hormone production levels of the pituitary glands in females and in males. Study Figure 7-2. Then answer Questions 7-1 and 7-2. If you have trouble reading the graph, study "Resource Unit 2: Reading Graphs."



Female
The pituitary gland releases chemical messages (egg-releasing hormones) that cause the release of eggs.



Male
The pituitary gland releases chemical messages (sperm-producing hormones) that cause the production of sperm.

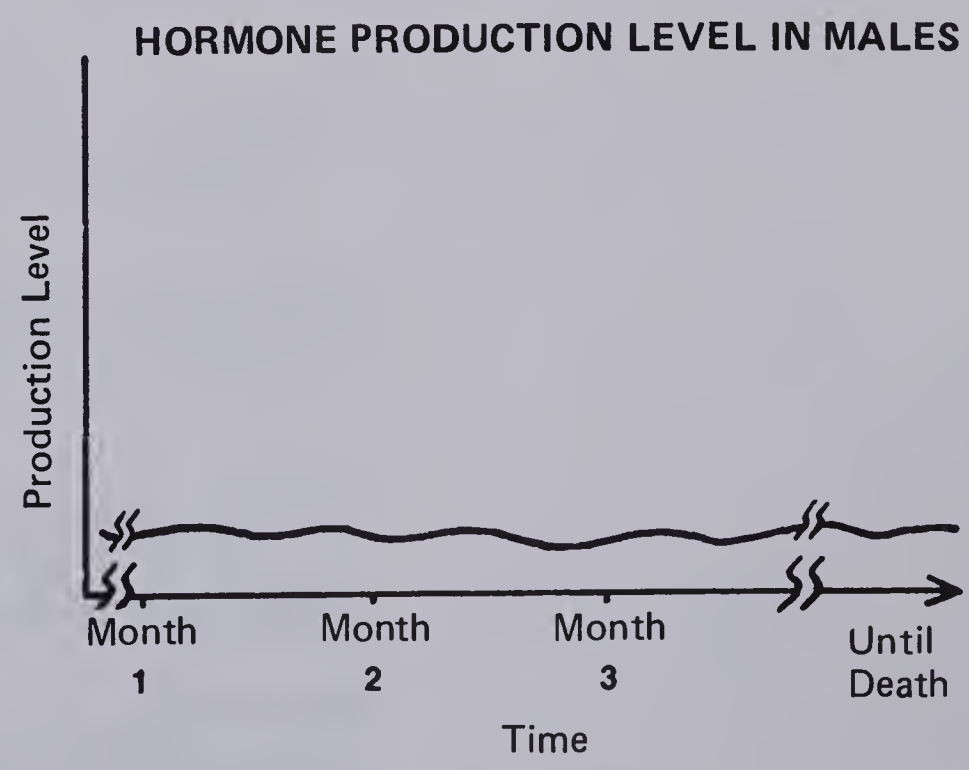


Figure 7-2

● 7-1. In most females, the release of eggs is
A. continuous — fairly steady.
B. periodic — a repeating pattern.
C. irregular — no pattern at all.

7-1. B

7-2. A

● 7-2. In most males, the production of sperm is
A. continuous — fairly steady.
B. periodic — a repeating pattern.
C. irregular — no pattern at all.

It seems that pituitary hormones have much to do with the menstrual cycle. That is, the hormones are released into the bloodstream only at certain times, and an egg is released by an ovary only at those times. The pituitary hormones seem to determine the time an egg is released.

Clues to the control of the female reproductive cycle are located in two very small structures. One, as you know, is the pituitary gland. The other is called the *hypothalamus* [hy-po-THAL-ah-mus]. Both of these structures are shown in Figure 7-3 below.

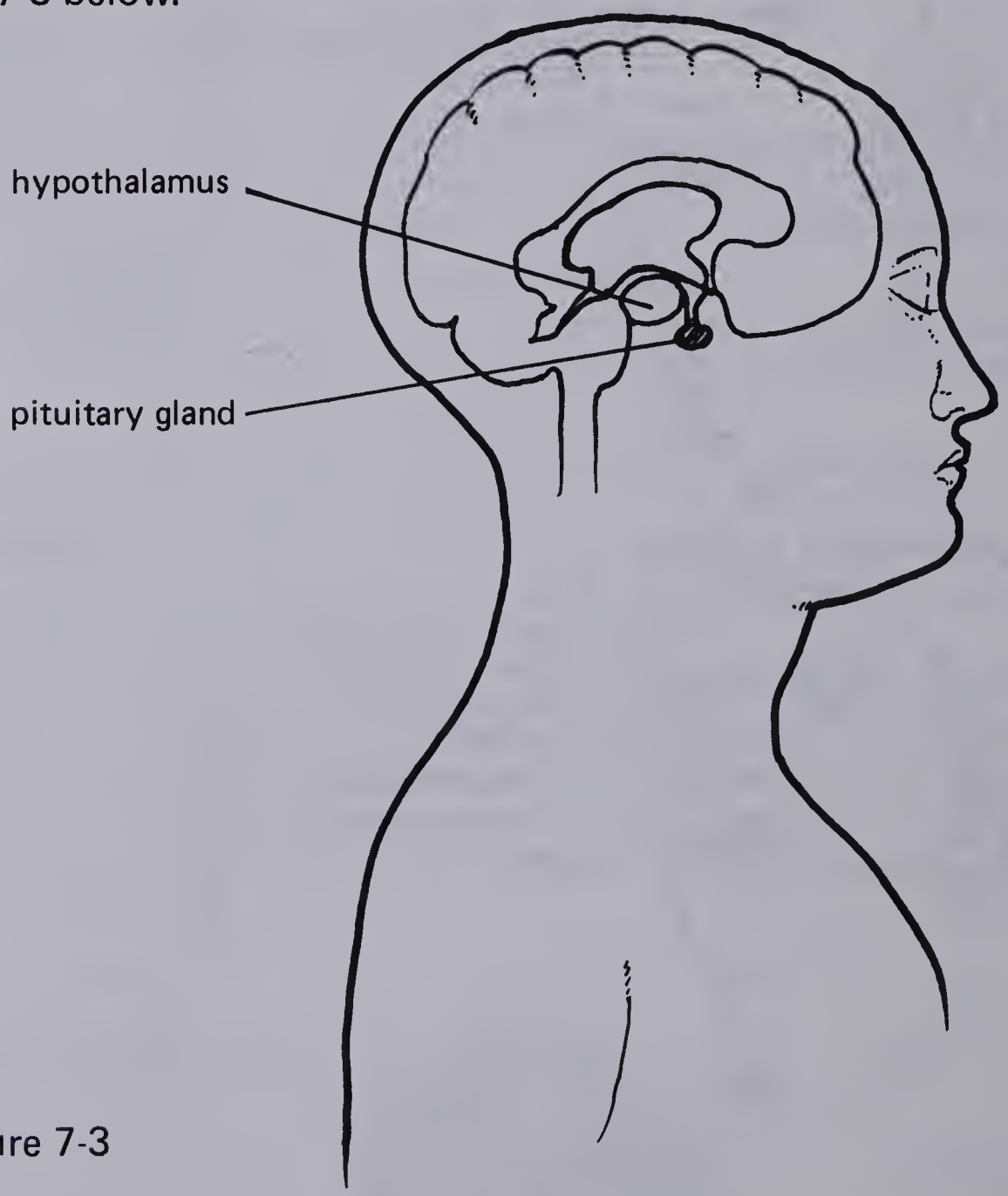


Figure 7-3

The hypothalamus is the main controlling center for unconscious processes regulated by the nervous system. It regulates various body functions, such as body temperature, appetite, sleep, blood pressure, and emotions. The hypothalamus also regulates the endocrine glands, including the pituitary gland.

The pituitary hormones are carried by the blood to various parts of the body. These hormones stimulate the production of other hormones in different glands. For example, the pituitary hormones stimulate the ovaries to produce ovarian hormones. Look at Figure 7-4 below.

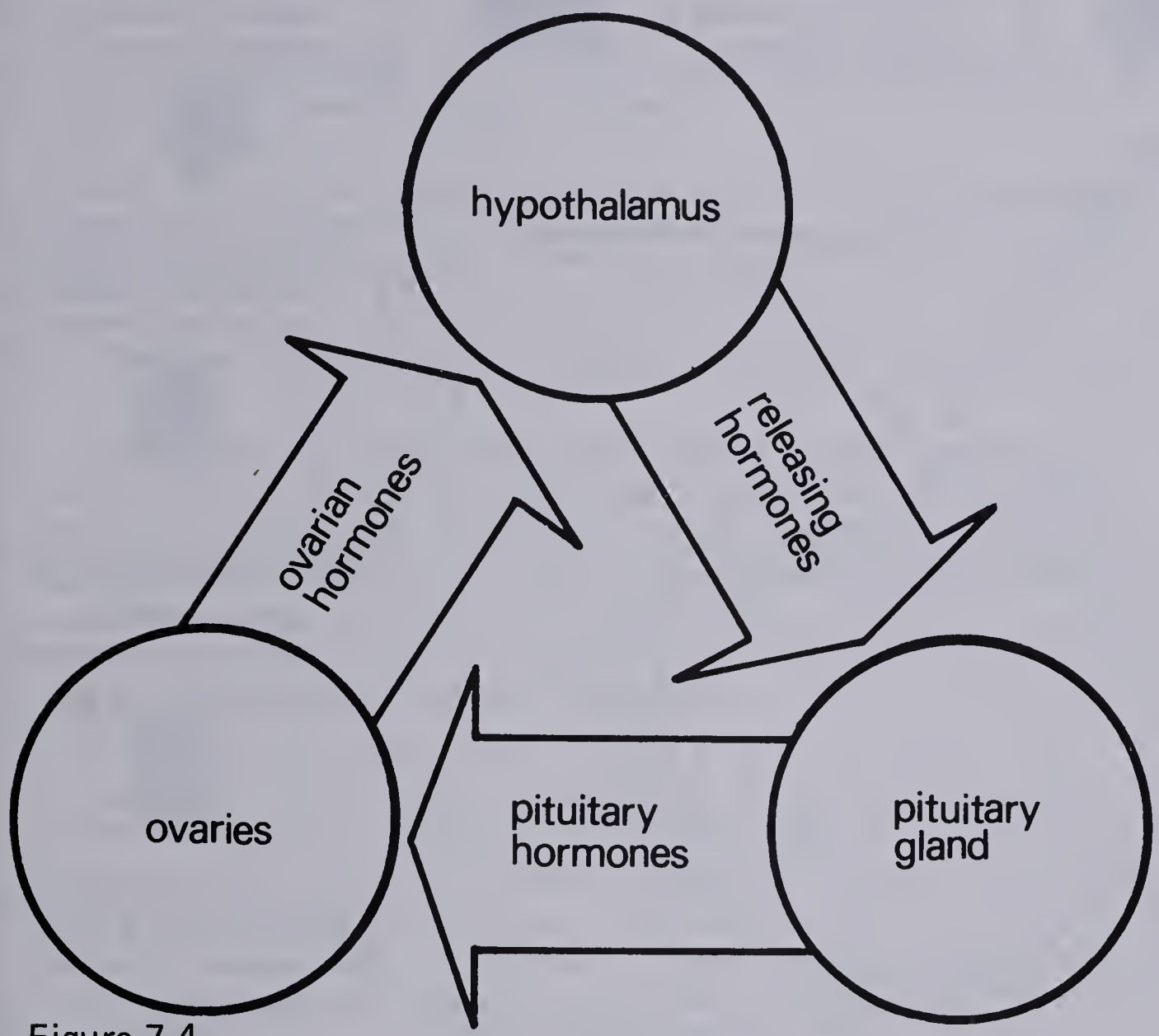


Figure 7-4

The presence of ovarian hormones causes the following changes.

- ✓ The follicle containing the egg matures, and the egg is released from the ovary.
- ✓ The uterine wall thickens.
- ✓ Water retention occurs and may cause the breasts to become tender during the second half of the menstrual cycle.

The sharp decline in the level of ovarian hormones causes the shedding of excess tissue in the uterine wall.

As the amount of ovarian hormones falls to a certain level, the drop is sensed by cells near the hypothalamus. Then the hypothalamus is stimulated to produce releasing factors that are carried to the pituitary gland. The releasing factors stimulate certain cells in the pituitary to produce increased amounts of hormones. The pituitary hormones are carried to the ovaries and cause the cycle to be repeated.

The events of the menstrual cycle are summarized in Figure 7-5 below. Carefully follow the events. Then answer the questions that follow the figure.

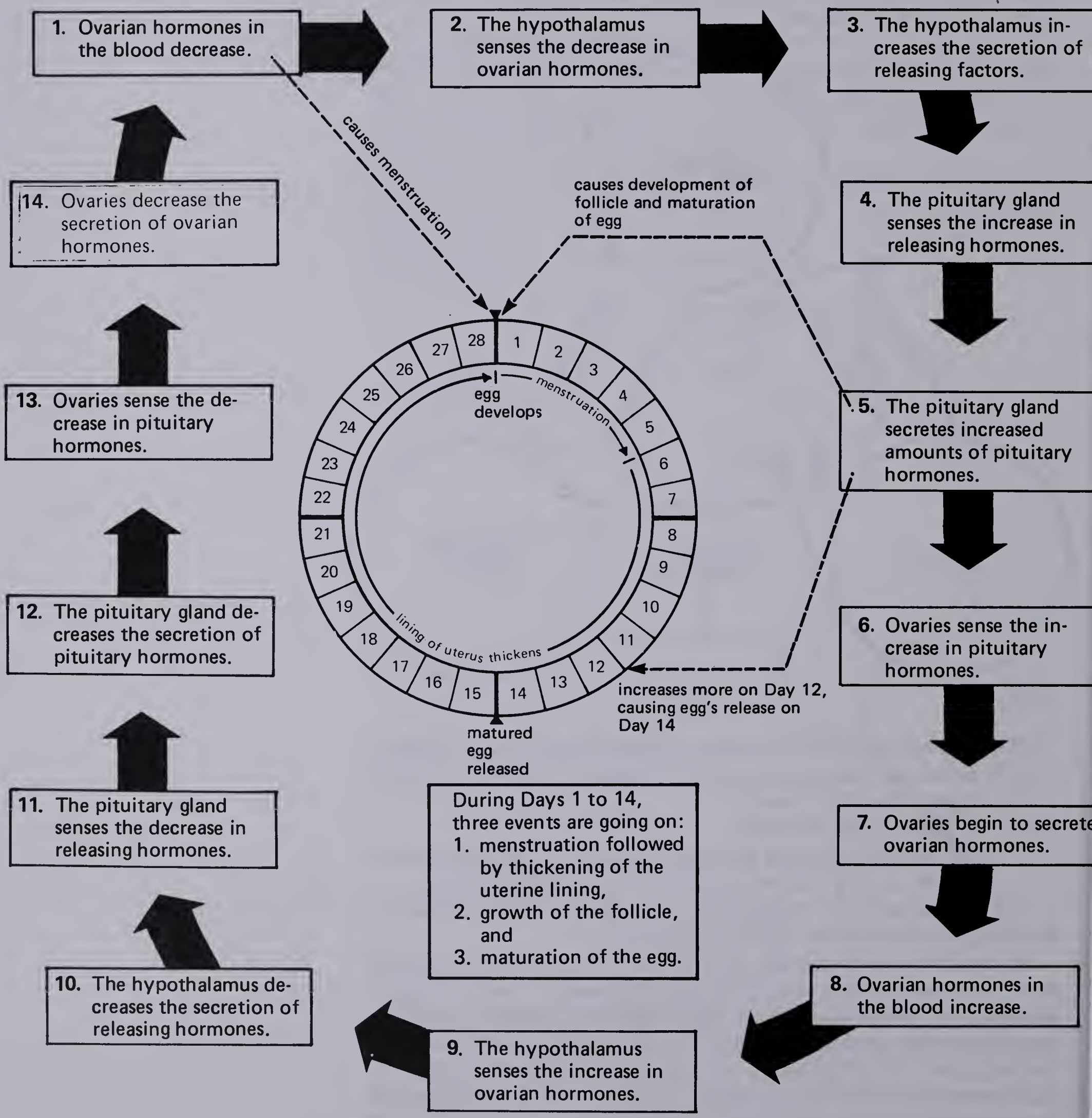


Figure 7-5

● 7-3. Which gland secretes hormones that cause an ovary to release an egg?

7-3. The pituitary gland

● 7-4. What causes the uterine wall to become thinner during menstruation?

7-4. A decrease in the level of ovarian hormones

● 7-5. What triggers the pituitary gland to secrete hormones that cause the uterine lining to thicken?

7-5. The hypothalamus secretes releasing factors.

● 7-6. The entire menstrual cycle occurs in approximately twenty-eight days. What happens after twenty-eight days, when the process is completed?

7-6. The cycle begins again (unless it is interrupted — by pregnancy for instance).

● 7-7. Why do you think the menstrual cycle is called a *cycle*?

7-7. The process begins and ends in the same place and is repeated over and over again at a regular rate.

As you can see, the menstrual cycle is a complex feedback-control system. The levels of different hormones in the menstrual cycle act to stimulate or suppress the various glands. When each hormone starts flowing, it causes changes that finally lead to its own flow being stopped. In this way, the parts of the system control each other and the system controls itself. That is the reason the system is called a *feedback-control system*. In fact, *feedback control* means "self-control."

If this is the first time you've heard about feedback control, don't worry if its meaning isn't completely clear. You'll see feedback control again in other minicourses. However, if you've seen it before and you still feel uncomfortable about it, you may want to take a look at "Resource Unit 13: Systems and Feedback." It describes feedback control in more detail.

Feedback Control

☆ **7-8. Why is it correct to say that the release of an egg by an ovary or a complete menstrual cycle is under feedback control?**

7-8. The time of the release of an egg and the changes in the uterine lining are controlled by levels of hormones that influence each other.

As in the case of all feedback systems, there may be interruptions in the cycle. Mental or physical stress — including anxiety, fatigue, malnutrition, and other environmental factors — sometimes influences all or parts of the cycle. Irregularities in the length of the cycle are common.

If you're interested in learning about specific hormones, you may want to do Activities 10 and 11.

See "Background Information" in ATE front matter for a more detailed discussion of hormones and the menstrual cycle.

ADVANCED

ACTIVITY 8: PLANNING

Activity 9 Page 33

Objective 9-1: Describe the steps in the development of sperm in the testes and eggs in the ovaries.

Sample Question: Arrange the following events in the order in which they occur in the ovaries or testes.

A. The germ cell in the reproductive organ divides. Each new cell receives one doubled chromosome from each chromosome pair.
B. The egg or sperm matures completely.
C. Chromosomes duplicate themselves.
D. Each new cell receives one chromosome from each of the doubled chromosomes.

Activity 10 Page 37

Objective 10-1: Tell where testosterone, FSH, and ICSH are produced in the human male and what changes those hormones cause in other parts of the body.

Sample Question: Match each hormone with the place it is produced and with one of its effects. (Answers may be used more than once.)

Hormone	Place and Effect
A. Testosterone	1. pituitary gland
B. FSH	2. testes
C. ICSH	3. makes sperm functional
	4. causes voice to deepen
	5. speeds testosterone production

Activity 11 Page 42

Objective 11-1: Describe the roles of estrogen, progesterone, FSH, and LH in controlling the human female menstrual cycle.

Sample Question: Match each hormone with one of its functions in the menstrual cycle.

Hormone	Function
A. Estrogen	1. causes corpus luteum to produce progesterone
B. FSH	2. causes uterine lining to begin to thicken
C. Progesterone	3. stimulates ovarian follicle to grow
D. LH	4. causes uterine lining to continue thickening

Answers: 9-1. C, A, D, B; **10-1.** A2, 4; B1, 3; C1, 5; **11-1.** A2, B3, C4, D1

ACTIVITY 9: MEIOSIS

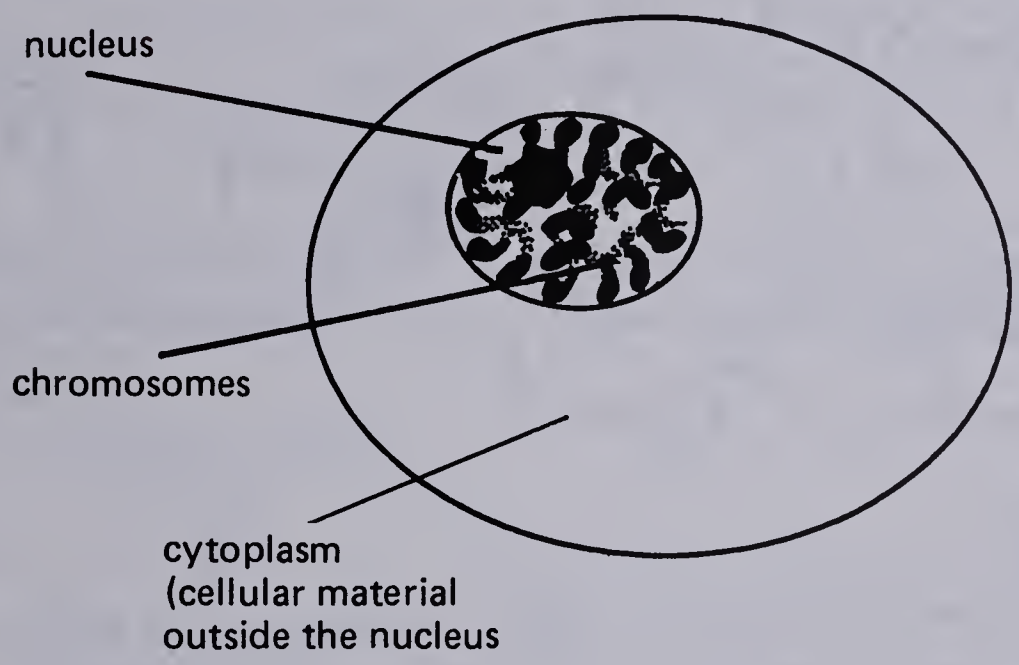
ACTIVITY EMPHASIS: The path of chromosomes is traced during meiosis and fertilization, with particular emphasis upon how the chromosome number is reduced to half during meiosis.

MATERIALS PER STUDENT LAB GROUP: None

As you know, each sperm cell and each egg cell contribute half the number of chromosomes needed for a new baby. You'll learn in this activity about the way the sperm cells and egg cells are formed.

In the human body, almost all cells — sex cells and body cells — contain a nucleus. The nucleus of a cell directs the development and the function of the cell. As shown in Figure 9-1 below, the nucleus contains chromosomes. They are threadlike structures of genetic material, as shown in the photograph. Chromosomes determine thousands of different characteristics, such as hair, eye color, and sex. Most body cells contain twenty-three pairs of chromosomes — forty-six chromosomes in all.

The only human cell that lacks a nucleus is the mature red blood cell.



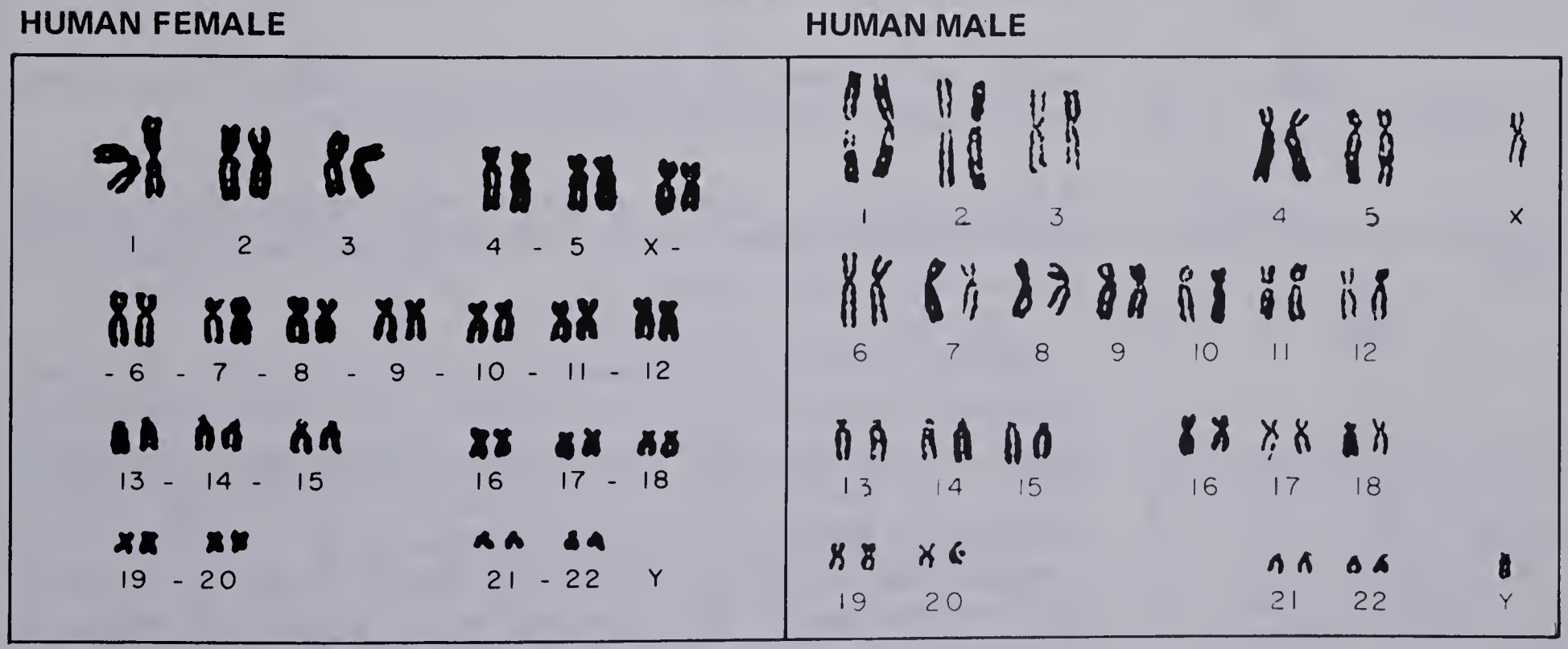


Figure 9-1

Figure 9-2 below shows changes in the number of chromosomes during human reproduction and growth. Study Figure 9-2. Then answer the questions that follow it.

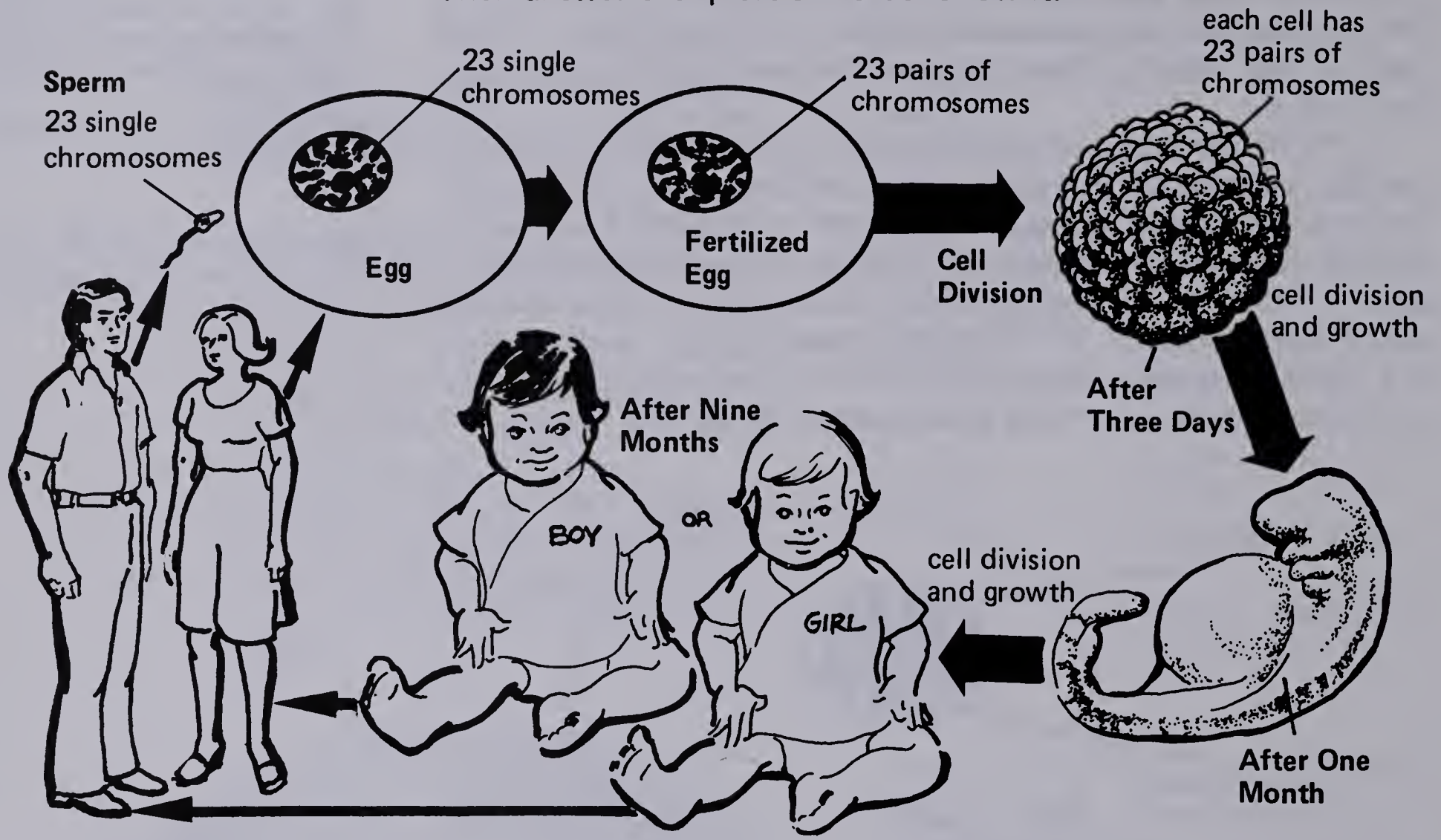


Figure 9-2

9-1. They unite and form twenty-three pairs of chromosomes (or forty-six single chromosomes) in the fertilized egg.

● 9-1. During fertilization, what happens to the twenty-three single chromosomes in the sperm and to the twenty-three single chromosomes in the egg?

9-2. Twenty-three pairs, or forty-six single chromosomes

● 9-2. A fertilized egg goes through cell division. How many chromosomes are contained in each resulting cell?

9-3. Twenty-three single chromosomes

● 9-3. Almost all cells in a human body contain twenty-three pairs of chromosomes. How many chromosomes are contained in a sex cell (sperm or egg)?

Human ovaries and testes are made up of body cells. Each cell has twenty-three pairs of chromosomes — forty-six chromosomes in all. But certain cells in the ovaries and testes divide in a special way. The resulting cells contain only half the number of chromosomes — twenty-three single chromosomes. These cells then become eggs or sperm. When cell division results in cells with half the number of chromosomes as the original cell had, the division is called *meiosis* [my-OH-sis].

The division of most body cells results in cells with full sets of chromosomes — twenty-three pairs. Such a division is called *mitosis* [my-TOE-sis]. Figure 9-3 below summarizes meiosis and mitosis.

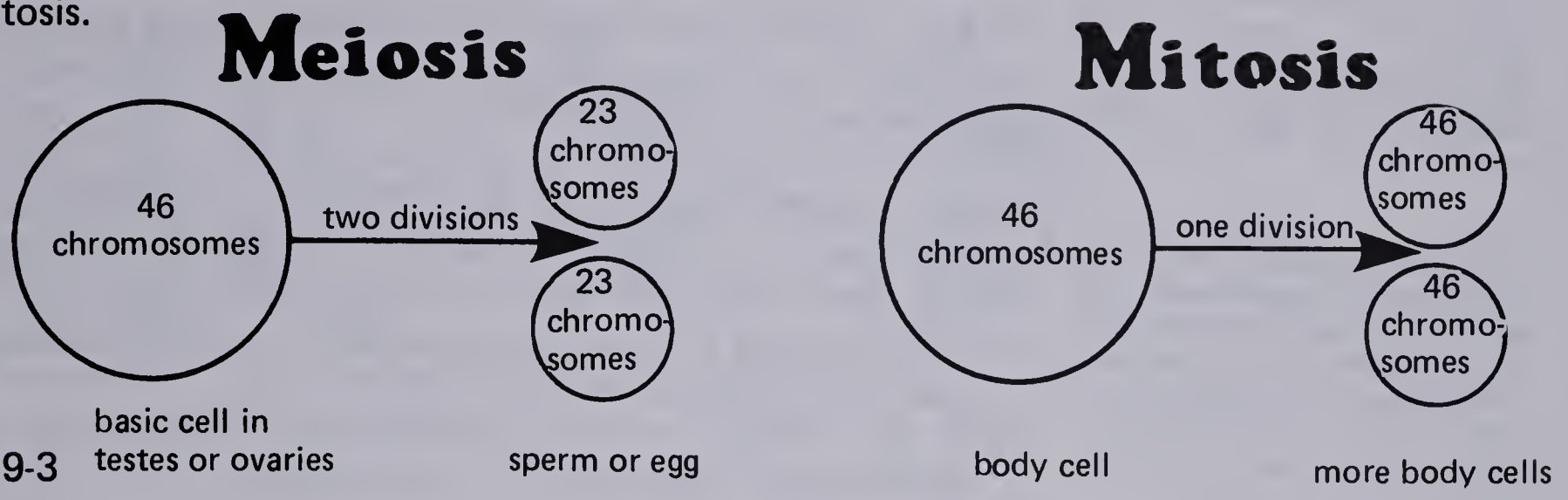


Figure 9-3

● 9-4. If an animal body cell has twenty pairs of chromosomes and divides by mitosis, how many chromosomes will each resulting cell have? If the cell divides by meiosis, how many chromosomes will each resulting cell have?

9-4. Twenty pairs — forty chromosomes in all; twenty single chromosomes

Study Figure 9-4 below to see what actually happens to the chromosomes during meiosis. Then answer the questions that follow it.

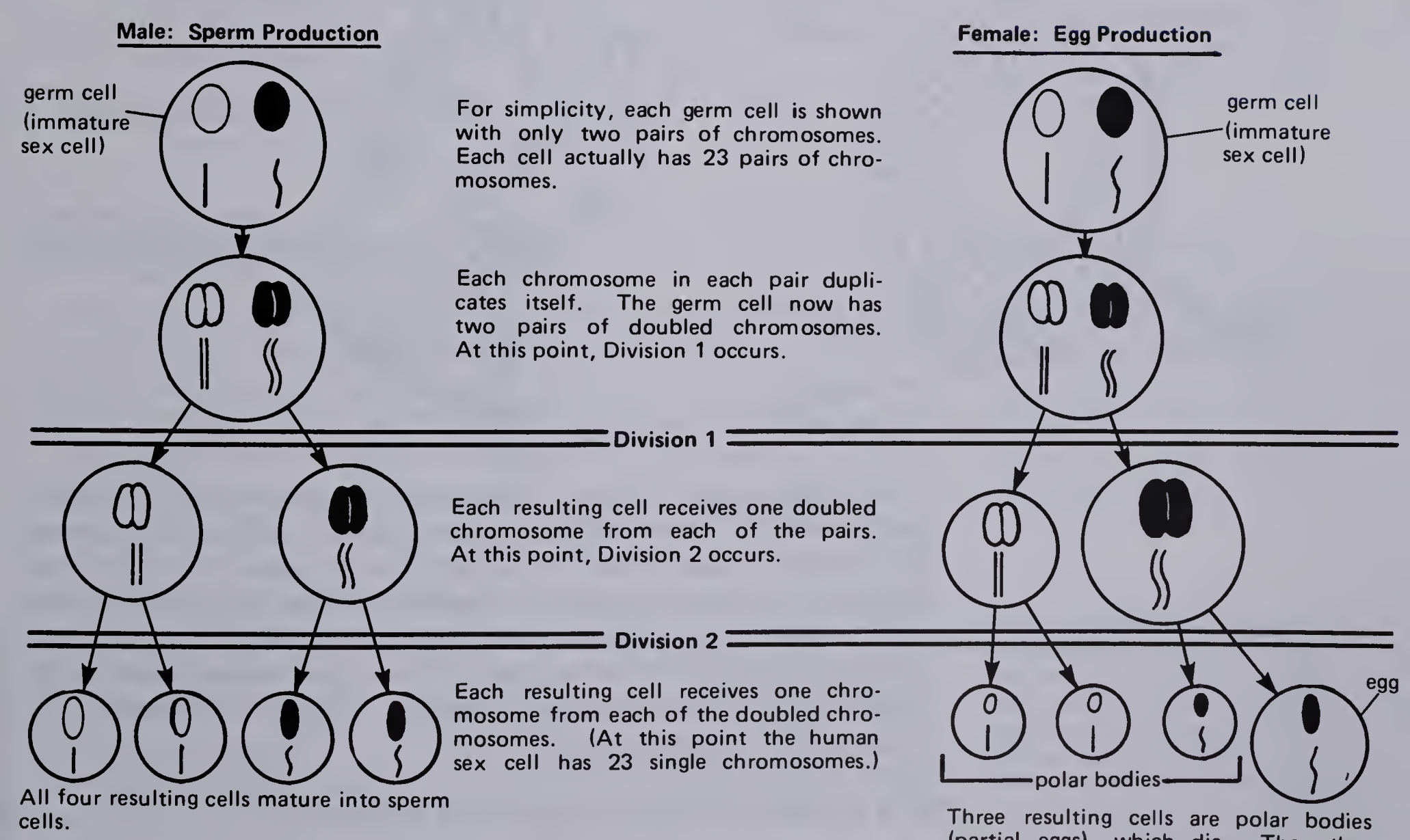


Figure 9-4

9-5. The chromosomes duplicate themselves before Division 1 so that after Division 1 there are 23 pairs of chromosomes in each resulting cell. The cells do not duplicate before Division 2, so after Division 2, there are 23 single chromosomes in each resulting cell.

☆ **9-5. Meiosis involves two cell divisions. What is the difference between Division 1 and Division 2?**

● 9-6. The cells that result from meiosis in egg production are different from those that result from meiosis in sperm production. What is the difference?

9-6. In egg production, four eggs are produced, but three are partial eggs (polar bodies) that die. One egg is a potentially functional cell. In sperm production, no polar bodies are produced. All four sperm cells are potentially functional cells.

● 9-7. List the following events in the order in which they occur during sperm formation. Then do the same for egg formation. (Hint: Some items will appear in only one list.)

A. A cell divides, and each resulting cell receives one chromosome from each chromosome pair.
B. A cell divides, and each resulting cell receives one doubled chromosome from each chromosome pair.
C. Each resulting cell will mature.
D. Chromosomes duplicate themselves.
E. One resulting cell will mature, and three will not.

9-7. D, B, A, C; D, B, A, E

In a male, meiosis occurs in germ cells (immature sex cells) in the testes. Figure 9-5 below shows a cross section of part of a testis.

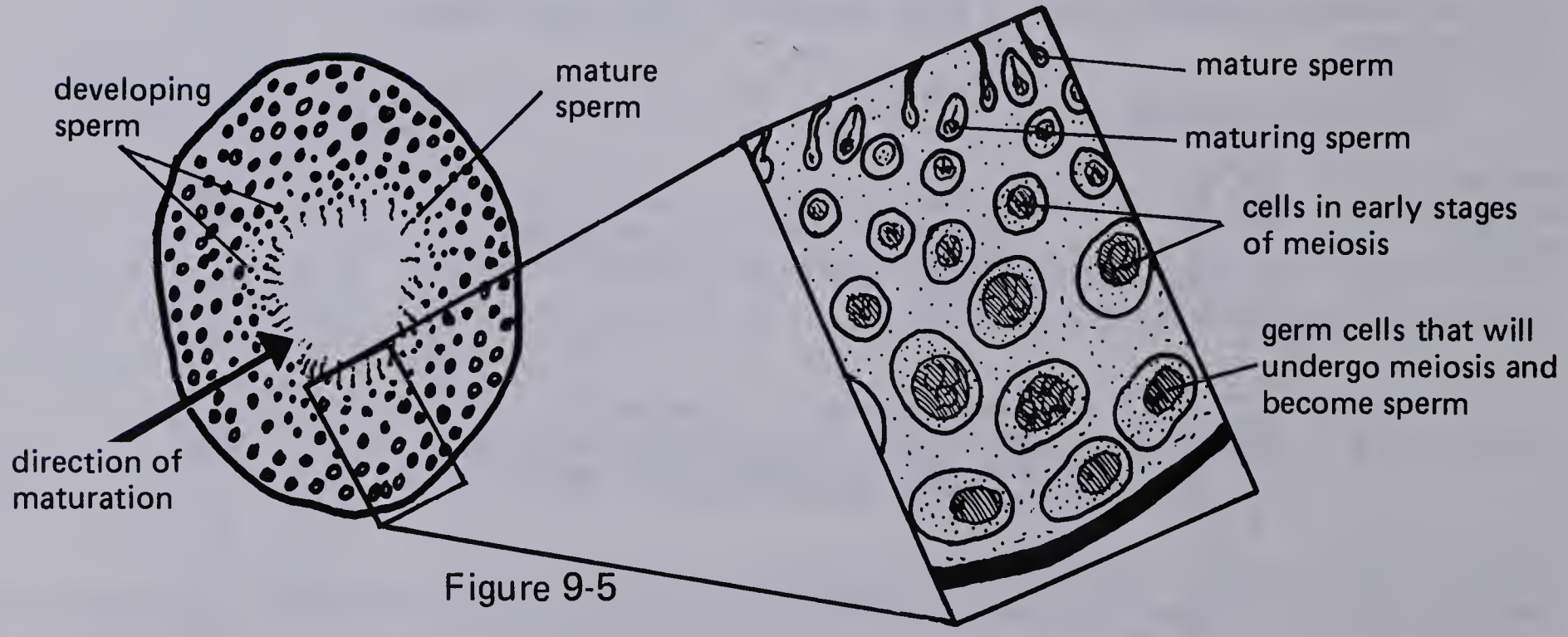


Figure 9-5

Near the outer edges of the testes, the germ cells are undergoing meiosis. The developing sperm cells are found closer to the center of the testes. As the germ cells gradually mature into four sperm cells each, new germ cells continue to form along the outer edges. The development and maturation of sperm cells, including the formation of tails, takes about seventy-four days. This is usually a continuous process in males and lasts from puberty until very late in life.

9-8. Sperm cells form from germ cells in the outer layer of the testes. New germ cells form and push the mature or older ones inward as they mature and develop tails during the approximately seventy-four-day developmental period.

☆ **9-8. Describe the development of sperm cells.**

In a female, meiosis occurs in germ cells in the ovaries. Figure 9-6 below shows a cross section of a human ovary and the stages of a developing egg within a follicle of the ovary.

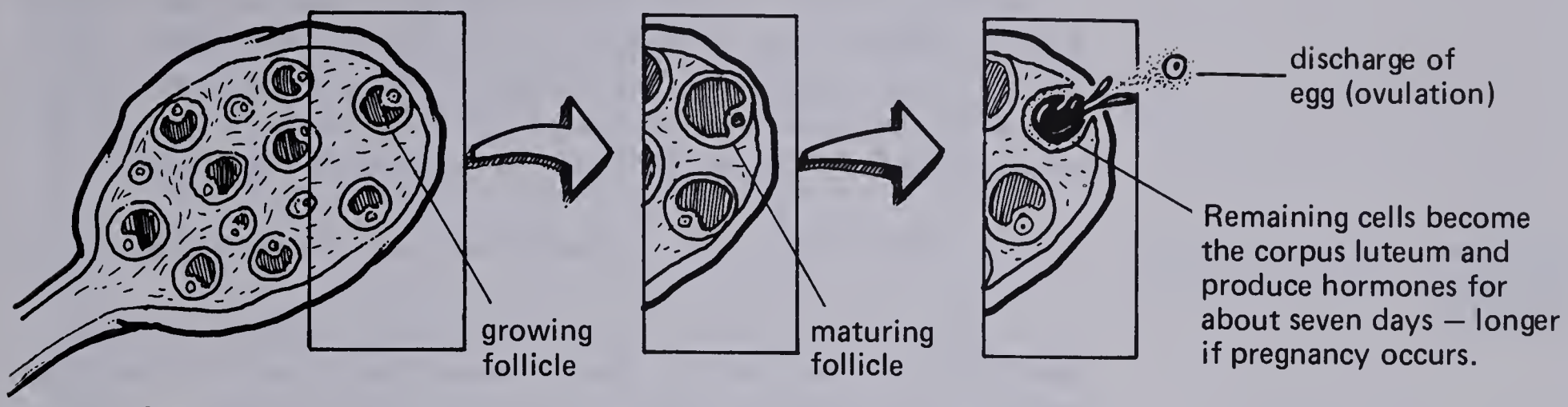


Figure 9-6

Each germ cell undergoes meiosis. It gradually matures into one egg cell. The three polar bodies die. Cells of the ovary surround the developing egg to form a follicle. During the twenty-eight-day period of development, the egg and follicle increase in size until the surface of the ovary ruptures and the egg is discharged. After the egg is released, the cells in the ruptured follicle become the corpus luteum, which secretes hormones.

If you're interested in learning about specific hormones secreted by the corpus luteum, you may want to do Activity 11.

☆ **9-9. Describe the development of egg cells.**

9-9. Eggs mature within cells in the ovary. The germ cells undergo meiosis. One of the four resulting cells matures, and three disintegrate. The mature egg is released, and the follicle cells, which surrounded the egg, produce hormones.

ACTIVITY 10: MALE HORMONES

ACTIVITY EMPHASIS: The primary focus is on the functions of testosterone in stimulating secondary sex characteristics, with secondary attention given to the feedback-control system involving testosterone and ICSH.

MATERIALS PER STUDENT LAB GROUP: None

Minute amounts of sex hormones are produced by the endocrine glands. They are released directly into the bloodstream. Because the amounts are so small, it has been very difficult for scientists to learn about sex hormones and their functions.

Years ago, some scientists suspected that the testes of animals functioned in important ways other than in the production of sperm. In 1849, a German scientist, Dr. Arnold Berthold, performed an experiment on chickens. First, he removed the testes of several young male chickens. These experimental birds developed into plump, mature birds called *capons*. They didn't crow like roosters or develop male combs, and they looked like female birds. Then, Dr. Berthold grafted a testis into the body cavity of each capon. (The testes had been removed from other male birds.) Soon the capons grew combs, crowed, and showed many other characteristics of male birds.

10-1. Testes are necessary for roosters to develop characteristics of male birds.

● 10-1. What might you conclude from Dr. Berthold's experiment?

In 1926, at the University of Chicago, Dr. Fred Koch performed a different experiment with capons. Dr. Koch injected each capon with a small amount of fluid that had been concentrated from about 18 kilograms of testes from bulls obtained from a slaughterhouse. The fluid caused male combs to grow on the capons.

10-2. Bulls' testes contain a substance that causes combs to grow on capons.

● 10-2. What might you conclude from Dr. Koch's experiment?

In 1935, in Amsterdam, Dr. Ernest Laquer isolated a pure substance from some similar concentrated fluid from the testes of bulls. The substance was five times more effective than Dr. Koch's concentrate in causing comb growth on capons. Dr. Laquer named the substance *testosterone* [te-STAS-ta-rown].

Since these experiments, scientists have learned that testosterone is also produced in the testes of human males. After release into the bloodstream, the hormone testosterone is carried throughout the body. It affects many body parts. See Figure 10-1 below for specific effects and results of testosterone.

BODY PART	EFFECT	RESULT
Testes	functional sperm produced	male becomes capable of fertilization
Hair follicles	new follicles become active	body and facial hair develops
Muscles	thicken	male body shape develops; greater strength gained
Skin	thickens	male skin texture develops
Brain	not fully understood	male sex urge develops*
Bones	faster calcium deposits	larger bones develop
Larynx	vocal cords thicken	deeper voice develops
Reproductive organs	enlarge	organs become functional

*The origin of the sex urge is complex. Testosterone is only one factor in its development.

Figure 10-1

The testes function in two ways: (1) as reproductive organs in the production of sperm and (2) as endocrine glands in the secretion of testosterone and other hormones. The production of testosterone in quantity starts when a human male reaches puberty (usually between ages eleven and seventeen) and continues most of his life. The graph in Figure 10-2 (page 39) shows the variation in testosterone secretion by a typical male during his life.

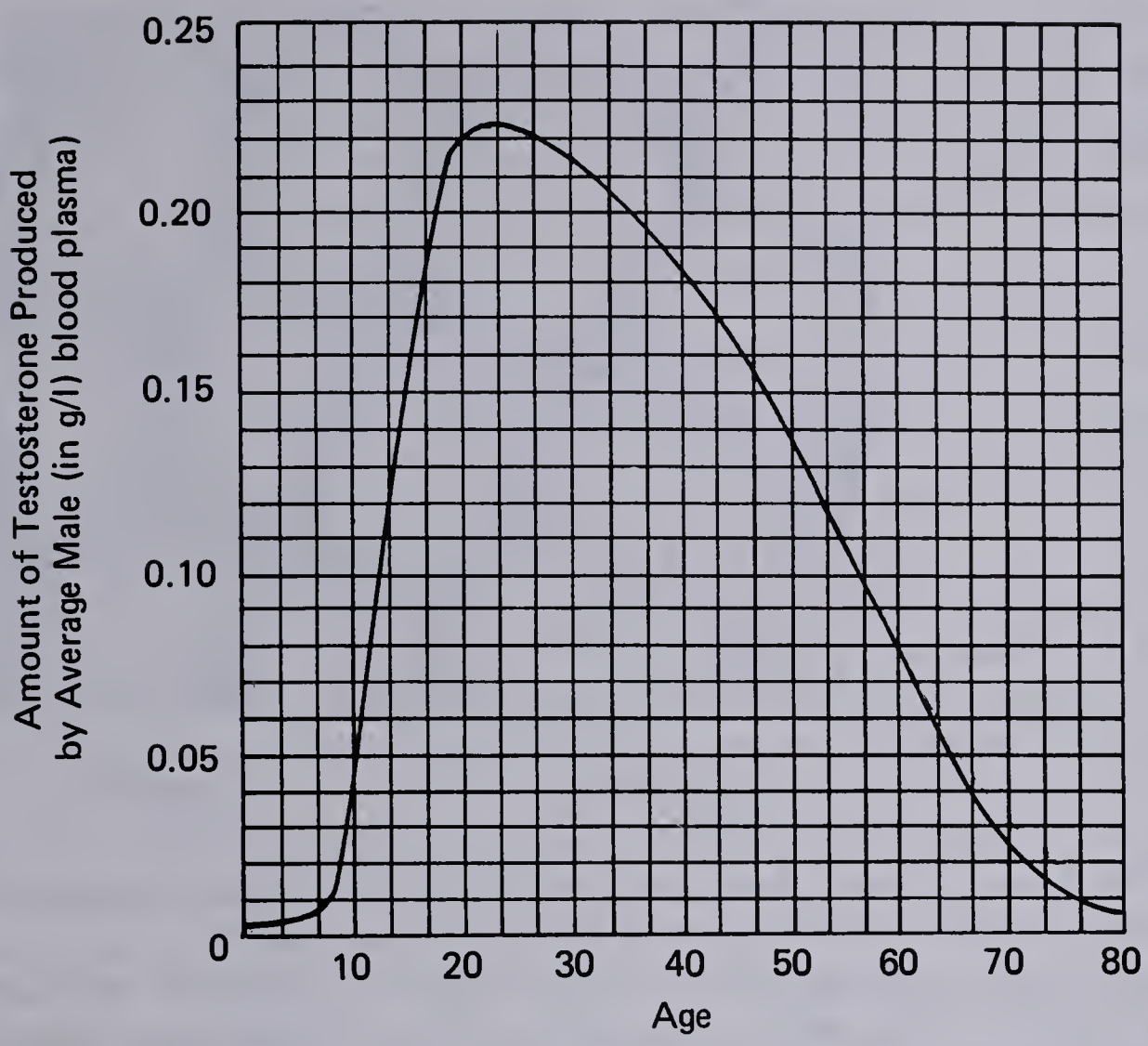


Figure 10-2

☆ **10-3. Why do most boys start to show adult male characteristics between ages eleven and seventeen? (Base your answer on data from Figures 10-1, page 38, and 10-2 above.)**

10-3. Testosterone begins to be produced in quantity at that time.

● 10-4. According to the graph in Figure 10-2 above, at about what age does testosterone production reach maximum level?

10-4. Between ages 20 and 25 (about 23)

● 10-5. Often, as men get older, their beards become less dense and their voices become higher pitched. Why do those things happen? (Base your answer on data from Figures 10-1 and 10-2.)

10-5. Testosterone production decreases, so male characteristics, such as beards and deep voices, become diminished.

● 10-6. Besides the changes described in Question 10-5 above, what changes would you expect men to experience as they get older? (Base your answer on data from Figures 10-1 and 10-2.)

10-6. The diminishing of all factors listed as "Results" in Figure 10-1

Male sex hormones are produced within the testes. Each testis is composed of a mass of tightly coiled seminiferous [sem-uh-NIF-uh-rus] tubules, as shown in Figure 10-3 (page 40). Sperm cells are formed within the tubules. Between the coils of the tubules are interstitial [int-er-STISH-ul] cells, or "cells between cells." Testosterone is secreted by those interstitial cells.

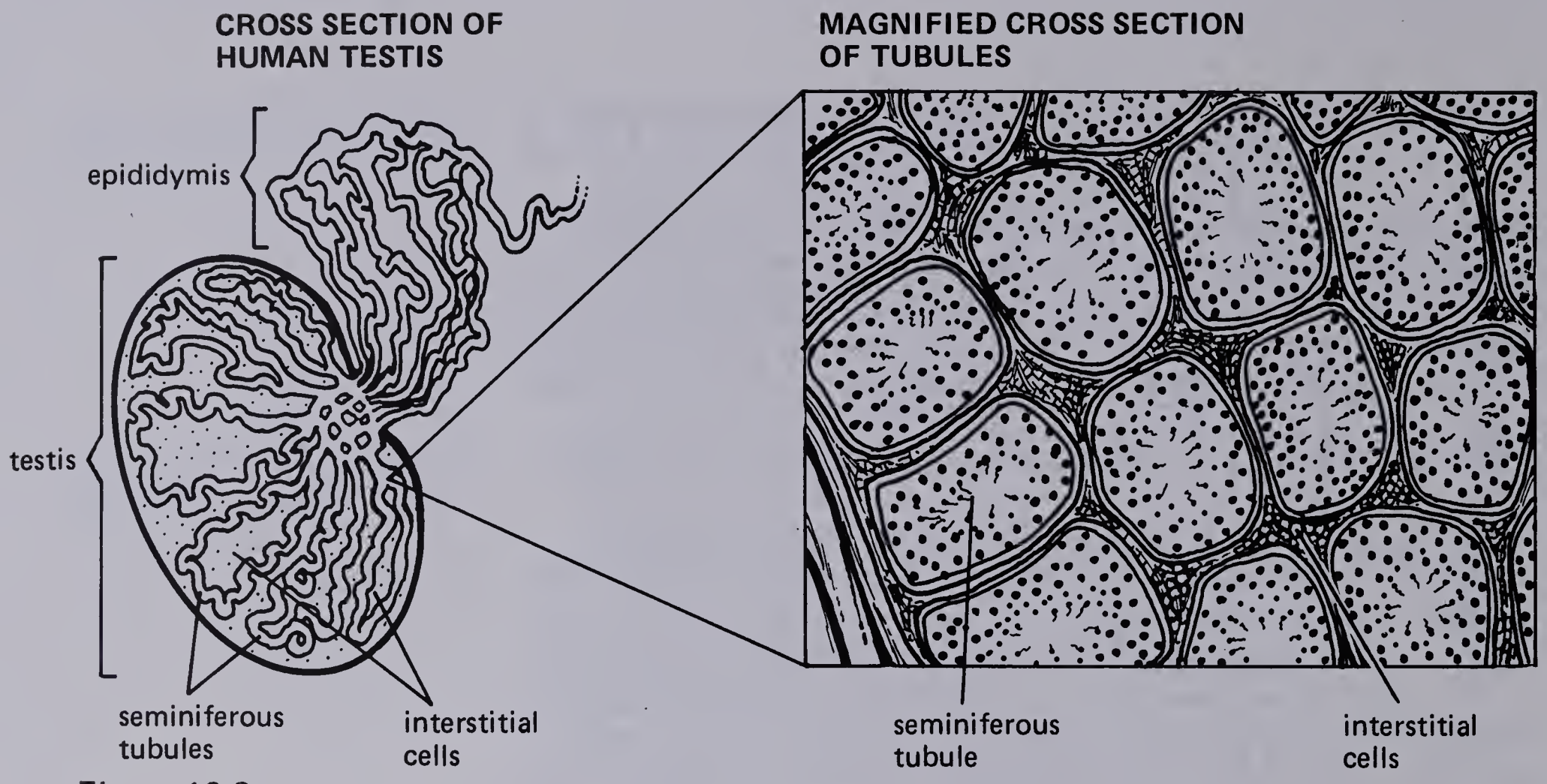


Figure 10-3

The human male's hormone system functions as a feedback-control system. This system is similar to the menstrual cycle of the human female in that, in both systems, hormones produce responses in other parts of the body. The responses regulate and control the action and level of hormones in another part of the body, which in turn regulate and control the action and level of the original hormone.

Figure 10-4 below shows ways that two hormones — testosterone and ICSH (interstitial cell-stimulating hormone) — influence each other.

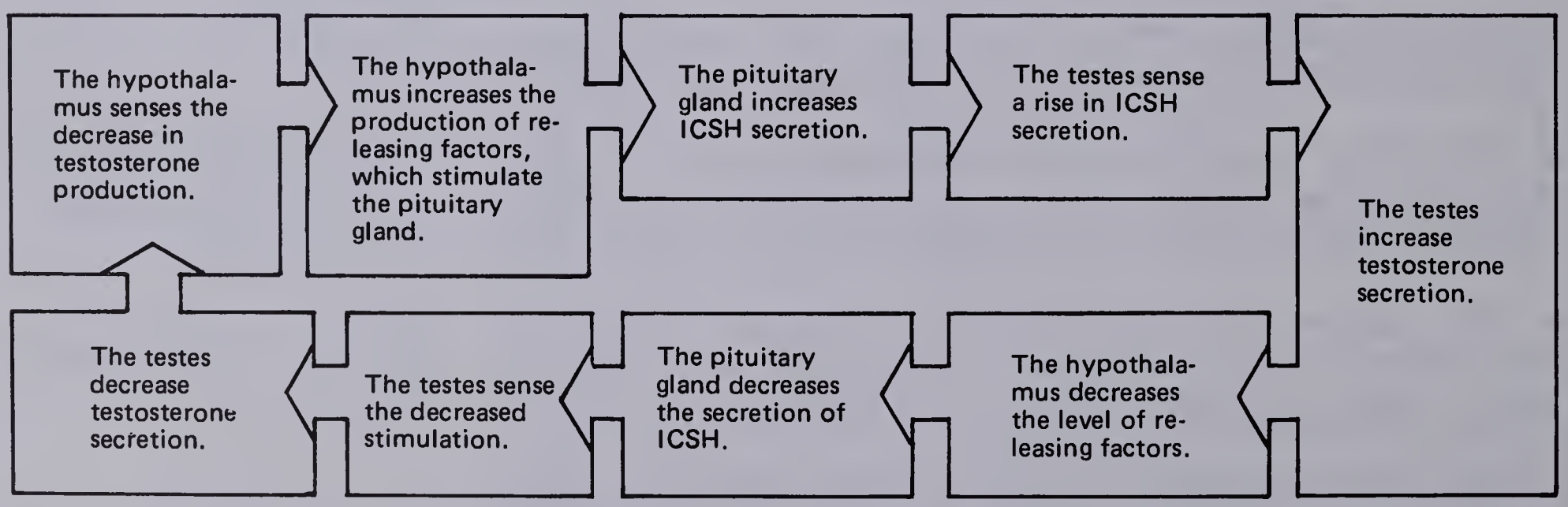


Figure 10-4

● 10-7. If testosterone production increased, what effect would the increase have on ICSH production? In turn, what effect would this have on testosterone production?

10-7. ICSH production would decrease. Testosterone production would also decrease.

The hormone FSH (follicle-stimulating hormone) is secreted by the pituitary gland in both females and males. It is the same hormone, but since it acts on the ovaries in females and on the testes in males, its effect is not the same. In females, FSH results in the maturing of eggs. In males, it leads to the production of mature sperm.

Another sex hormone that is secreted by the pituitary gland in both females and males is ICSH, although in females it is called *LH* or *luteinizing* [LOOT-e-uh-nize-ing] *hormone*. In females, LH causes the development of the corpus luteum, which forms in an ovary after the rupture of a follicle. In males, ICSH acts on the testes to speed testosterone production.

It is interesting that the ovaries of a female secrete small amounts of testosterone. Usually, testosterone seems to have little effect on females. This is probably the case because large amounts of estrogens (female hormones) are secreted. Similarly, very small amounts of estrogens are secreted by the testes of a male. But estrogens usually seem to have little effect on males, probably because so much more testosterone is produced.

● 10-8. Tell whether the following statement is true or false. Both males and females produce testosterone, FSH, and estrogens. But males produce mainly testosterone and FSH, whereas females produce mainly estrogens and FSH.

10-8. True

The data in Figure 10-5 below concern the hormones testosterone, FSH, and ICSH. Study the data. Then answer Questions 10-9 and 10-10 below the figure.

10-9. The testes; the pituitary gland; the pituitary gland

PRODUCING GLAND	HORMONE	EFFECTED GLAND	EFFECT ON GLAND
Testes	testosterone	pituitary gland	slows FSH production
			slows ICSH production
Pituitary	follicle-stimulating hormone (FSH)	testes	starts sperm production
	interstitial cell-stimulating hormone (ICSH)		speeds testosterone production

Figure 10-5

10-10. Testosterone seems to have little effect on females. In males, it causes male characteristics to develop. FSH causes the maturing of eggs in females and the production of mature sperm in males. ICSH is called *LH* in females and causes the development of the corpus luteum. In males, ICSH acts on testes to speed testosterone production.

☆ **10-9. In a human male, where is testosterone produced? FSH? ICSH?**

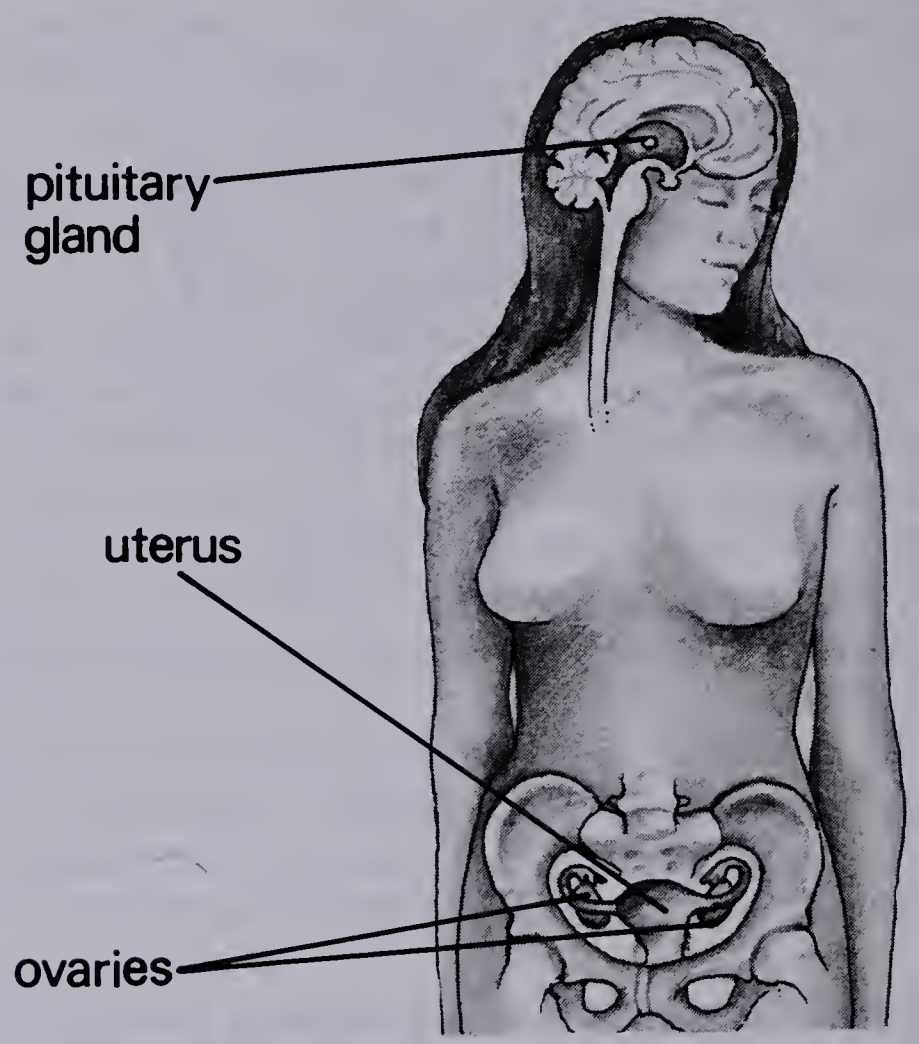
☆ **10-10. What changes does testosterone cause in the human female? Does FSH cause? Does ICSH cause? What changes do they each cause in the human male?**

ACTIVITY EMPHASIS: During the female menstrual cycle, follicle-stimulating hormone (FSH) causes an ovum to mature, luteinizing hormone (LH) causes it to be released, and estrogens and progesterone cause the uterine wall to thicken. In addition, there are inhibiting and stimulating relationships between the hormones.

MATERIALS PER STUDENT LAB GROUP: None

ACTIVITY 11: FEMALE HORMONES

General functions of hormones were discussed in Activity 7. In this activity, you'll learn more about hormonal control of the menstrual cycle. You'll also learn more about the functions of the pituitary gland, the uterus, and the ovaries.



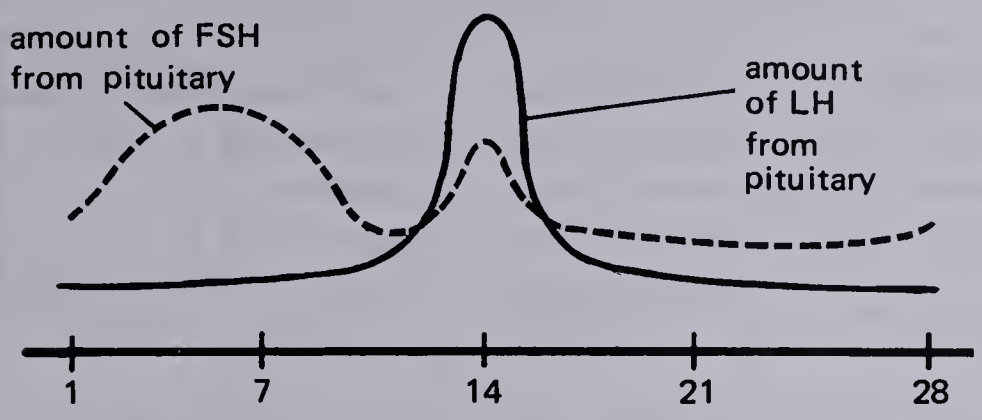
Endocrine glands secrete hormones into the bloodstream. The hormones, carried by the blood, travel to other parts of the body where they usually cause some changes to occur.

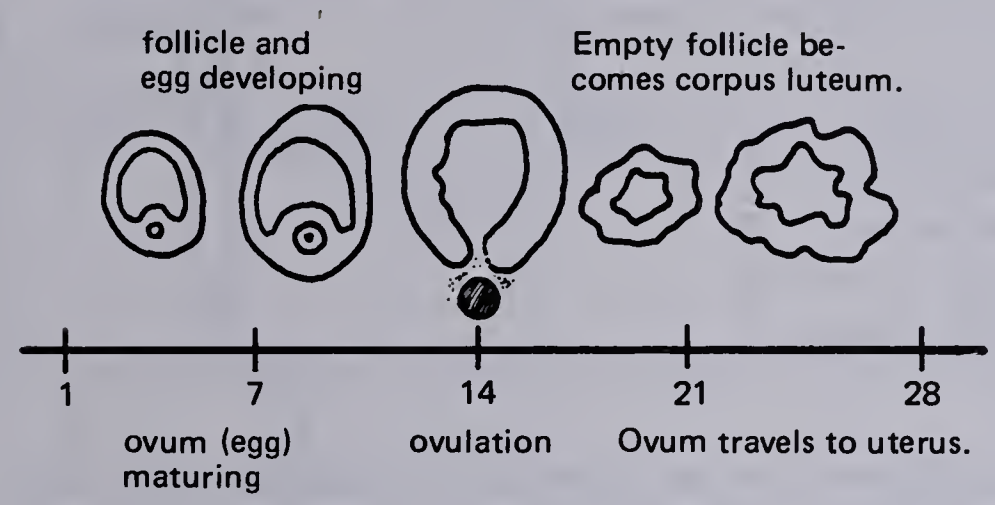
Four of the hormones involved in the menstrual cycle are listed below. Releasing factors, also listed, are chemicals that affect the pituitary gland. The functions of the hormones and releasing factors are summarized in Figure 11-1 (page 43).

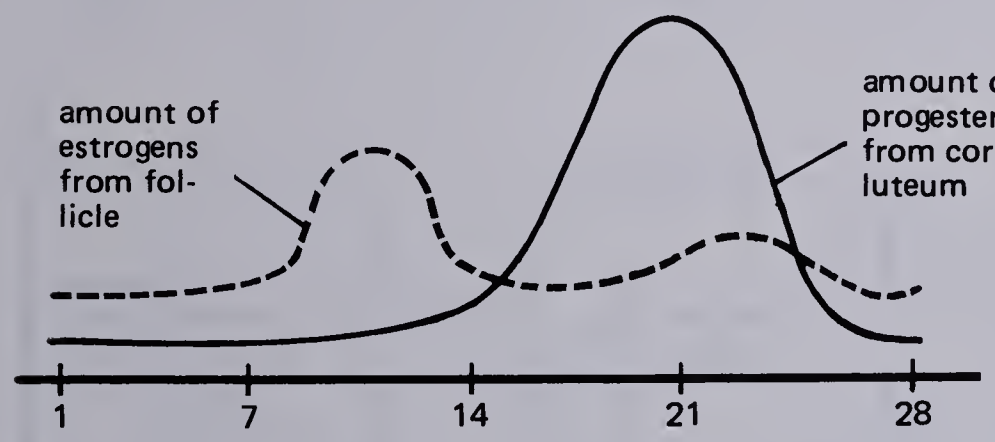
Follicles are composed of cells arranged as a sphere surrounding a fluid-filled space with an egg anchored to one area of the wall but projecting into the fluid.

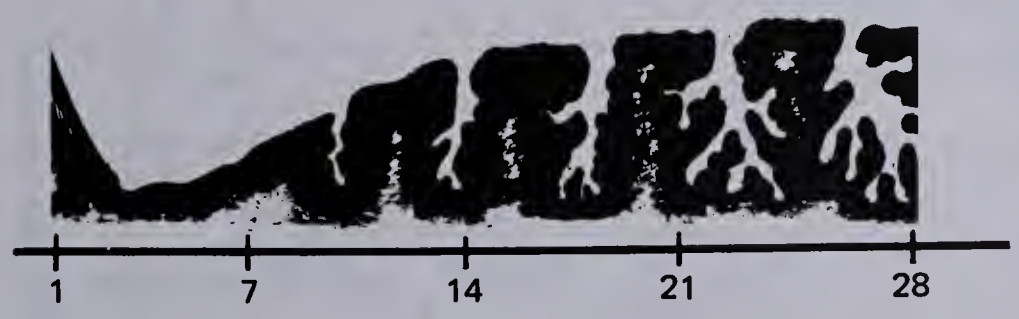
- ✓*Follicle-stimulating hormone* (FSH) is secreted by the pituitary gland near the base of the brain. The "follicle" part of the name refers to the follicles that surrounded the developing ova (eggs) in the ovaries.
- ✓*Luteinizing* [LOOT-e-uh-nize-ing] *hormone* (LH) is secreted by the pituitary gland.
- ✓*Estrogens* [ES-tra-jenz] are hormones secreted by follicles as they develop in the ovaries.
- ✓*Progesterone* [pro-JES-tuh-rown] is a hormone secreted by cells of the corpus luteum — the cells of a follicle after the mature egg has been released.
- ✓*Releasing factors* are chemicals secreted by cells of the hypothalamus.

The interrelationships among hormones and the events of the menstrual cycle are shown in Figure 11-1 below. Study the information given there. Then answer Questions 11-1 and 11-2 that follow it.









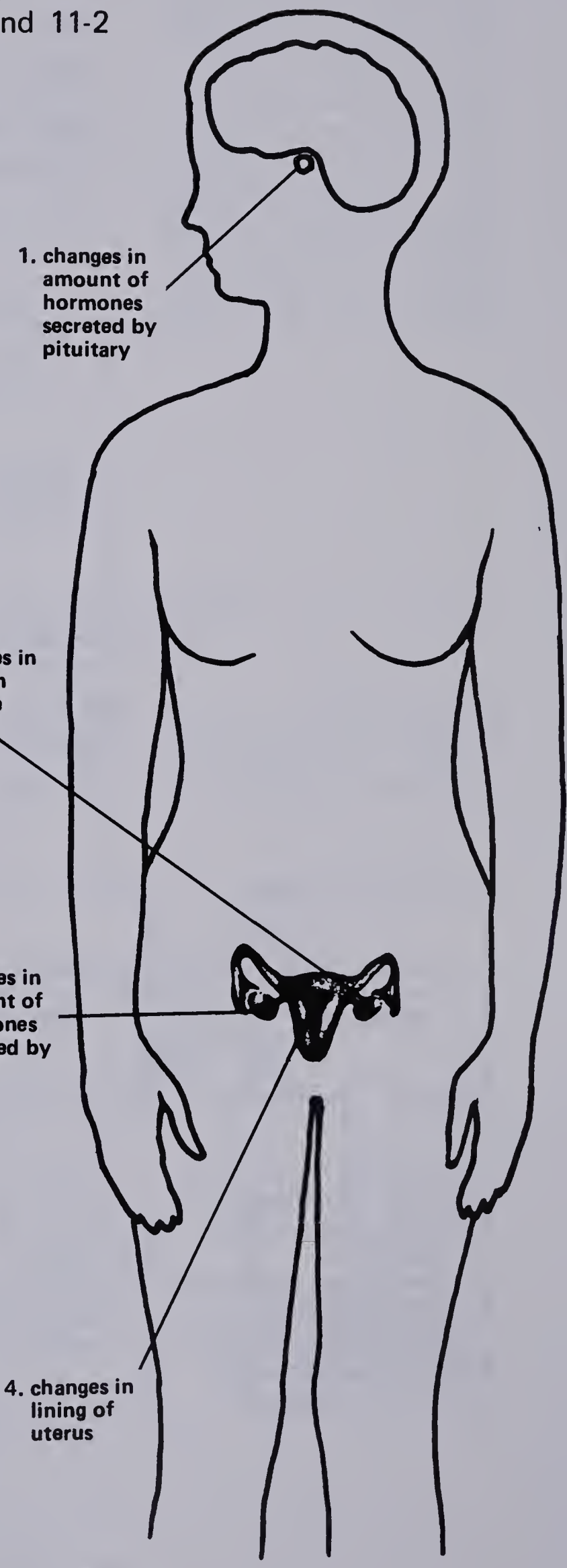


Figure 11-1

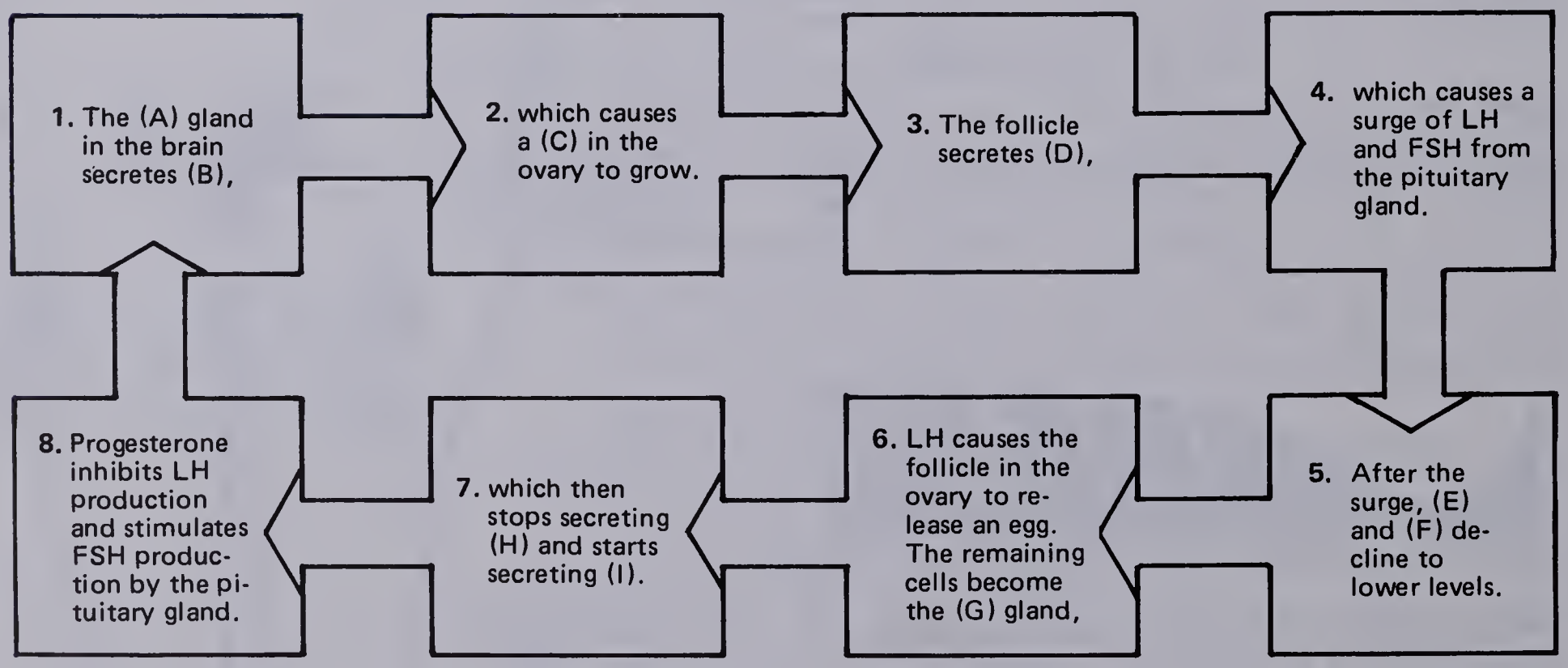
11-1. A. Menstruation: B. FSH level decreases and then increases, and LH level increases: C, estrogen level increases; D. egg matures and is ready to be released; E. lining thickens; F. egg is released and travels toward uterus, and corpus luteum is forming; G. 18 through 28; H. estrogen level is high and then decreases, and progesterone level increases and then decreases; I. egg travels toward uterus, and corpus luteum is forming; J. lining continues to thicken and then starts thinning

☆ **11-1. Copy the table below into your notebook. Then complete your table by supplying the missing information for Parts A through J.**

DAYS	EVENTS OF MENSTRUAL CYCLE			
	In Pituitary	In Ovary	In Egg	In Uterus
1 through 5	FSH production increases.	Follicle begins development. Estrogen production begins.	Egg begins development in follicle.	(A)
6 through 13	(B)	(C)	(D)	(E)
14 through 17	FSH production and LH production fall.	Estrogens are at highest level.	(F)	Lining thickens.
(G)	LH production and FSH production are at lowest point and then increase.	(H)	(I)	(J)

11-2. A. Pituitary; B. FSH; C. follicle; D. estrogens; E. LH; F. FSH; G. corpus luteum; H. estrogens; I. progesterone

☆ **11-2. Copy the diagram below into your notebook. Then complete the diagram by supplying the correct words for Letters A through I.**



If you answered Question 11-2 correctly, you can read the contents of the boxes in order and follow the arrow to understand the feedback system of the menstrual cycle.

When an egg is fertilized, the menstrual cycle is interrupted. The fertilized egg implants in the uterus. Estrogens and progesterone are secreted by the placenta, which develops within the uterus. The estrogens and progesterone prevent the pituitary gland from producing FSH. No new eggs are formed in the ovary as long as those substances are produced. Look at Figure 11-2 below.

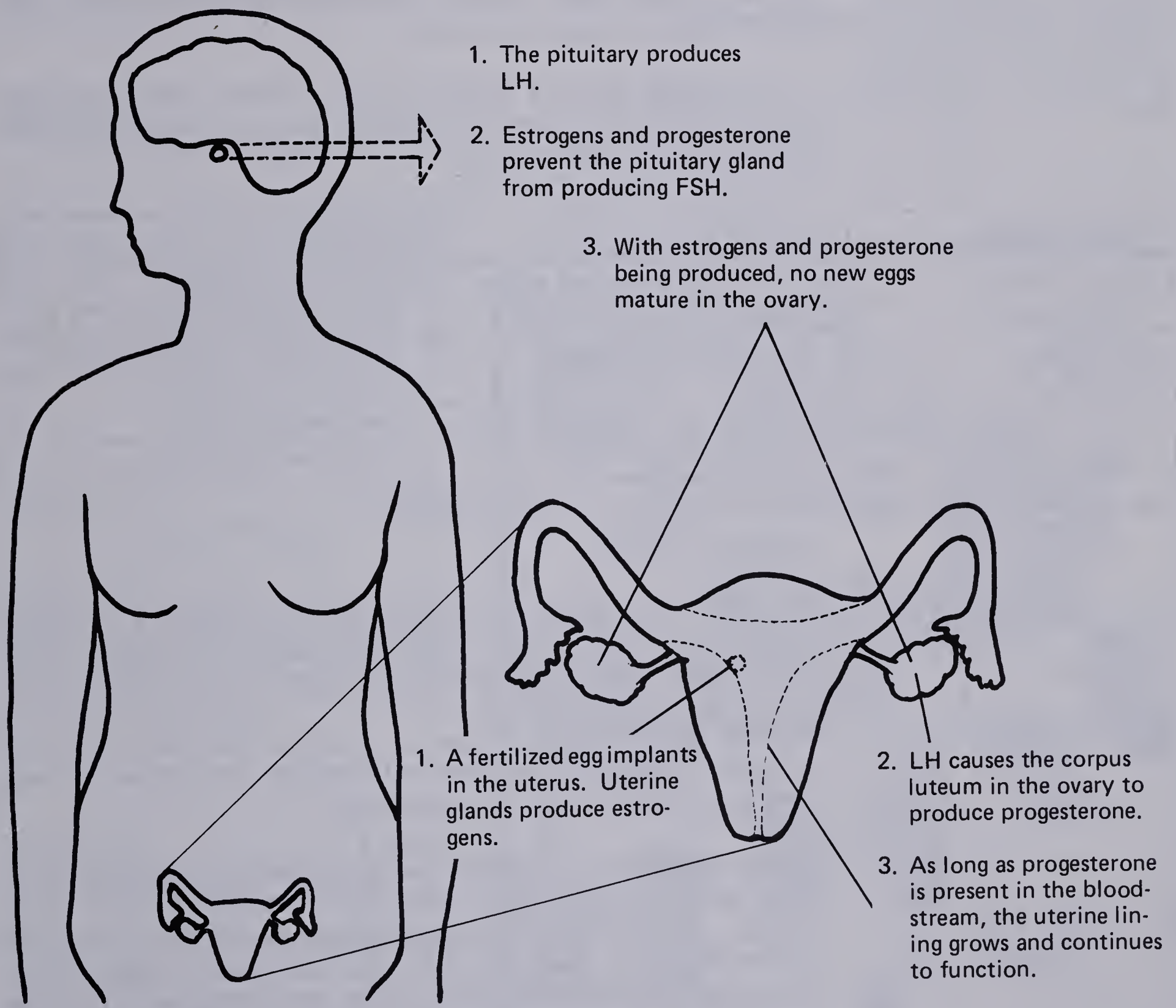


Figure 11-2

After the surge of LH on Day 14 of the menstrual cycle, LH is secreted at low levels. If fertilization occurs, the fertilized egg takes five days to descend through the fallopian tube to the uterus. During that time, the egg divides. On implantation, the developing mass of cells secretes substances that help continue the pregnancy.

During pregnancy, a woman usually does not ovulate or menstruate. The menstrual cycle begins again after the birth of the baby. If the mother nurses the baby, the menstrual cycle may not begin until she stops.

11-3. Usually menstruation does not occur when estrogens and progesterone are being secreted. This occurs when a fertilized egg has implanted in the uterine lining.

● 11-3. Explain why missing one or two menstrual periods may be considered a sign of pregnancy.

In addition to their effects on the pituitary gland, estrogens affect many other parts of the body. Some of these effects are shown in Figure 11-3 below.

BODY PART	EFFECT	RESULT
Hair follicles	new follicles become active	pubic hair develops
Pelvic bones	change in size and shape	female body develops
Fat cells	extra fat deposits form	female body shape develops
Breasts	enlarge	become functional
Reproductive organs	enlarge	become functional
Brain	not fully understood	female sex urge develops*

*The origin of the sex urge is complex. Estrogen is only one factor in its development.

Figure 11-3

11-4. The production of estrogens increases between ages eleven and fourteen so that the effects become apparent.

● 11-4. The effects of estrogens listed in Figure 11-3 above usually appear in females between the ages of eleven and fourteen. What does that suggest about the production of estrogens?

11-5. The production of estrogens slows drastically about then.

● 11-5. The menstrual cycles of most women stop when the women are between ages forty and fifty-five. What does that suggest about the production of estrogens?

Besides secreting estrogens and progesterone, ovaries secrete a small amount of the male hormone testosterone [te-STAS-ta-rown]. The function of testosterone in the female body is not understood. Its effect does not seem to be great. Since testosterone and estrogens produce almost opposite effects, the large amounts of estrogens probably overpower possible effects of testosterone.

EXCURSION

ACTIVITY 12: PLANNING

In Activity 13, you can observe the growth and development of chicken embryos. Since it will take time for the embryos to develop, do Activity 13 first if you plan to do it.

Activity 13 Page 48
Watching Life Develop

People enjoy watching children grow and develop after birth. But they usually miss seeing the development that takes place before birth. In this excursion, you will use chicken eggs to see some very early stages of life.

Activity 14 Page 54
Twins and Triplets

People usually have their children one at a time. But sometimes a multiple birth of two, three, or even more children occurs. In this excursion, you can read about how that happens.

Activity 15 Page 60
Biological Family Planning

Natural methods of family planning can help couples to have the number of children they want at the times they choose. It can also help to prevent unwanted pregnancies.

Activity 16 Page 65
Family Planning Methods

This activity surveys some artificial devices and techniques currently used in family planning. Information is given on the way they work, their effectiveness, and the availability of each.

Activity 17 Page 72
Venereal Diseases

Venereal diseases are very widespread and often difficult to identify in their early stages. Therefore, the things you learn in this activity may affect your future life.

ACTIVITY EMPHASIS: Early human and chicken embryos show similar patterns of differentiation and development. Students observe development in live chicken embryos.

MATERIALS PER STUDENT LAB GROUP: See tables in "Materials and Equipment" in ATE front matter. See "Advance Preparations" in ATE front matter.

IMPORTANT: You may want students to begin this activity before any others in the minicourse in order to complete it about the time they complete the minicourse.

ACTIVITY 13: WATCHING LIFE DEVELOP

In this activity, you'll observe the growth and development of chicken embryos. A chicken requires twenty-one days of incubation before hatching. So plan to continue this activity for that amount of time. (You'll be able to work on other activities in this or another minicourse at the same time.)

Some of the most fascinating events of development occur in the earliest stages — before an animal is born or hatched. It usually isn't possible to watch directly the early stages of a human being's development. But all animals with backbones develop through similar changes. There is a close resemblance, for instance, between a human embryo and a chicken embryo, as you can see in Figure 13-1 below.

Figure 13-1

Prepare for the investigation in this activity. Read the entire activity before beginning the investigation. It helps to know the overall direction of the activity as you work on each step.

Before beginning the investigation, check to make sure that the incubator temperature has been maintained at 37°C for at least two days. The incubator will have to run continuously for twenty-one days after the two-day test run.

The days on which you'll be doing steps of the investigation are summarized in Figure 13-2 (page 49). The days are counted consecutively from Day 1 — the first day of the investigation.

INVESTIGATION TIMETABLE	
Day	Steps to Complete
1	A through H
5	I
8	J through M
13	N
19	Put water and food into incubator for chicks.
21	O

Figure 13-2

You will need the following materials.

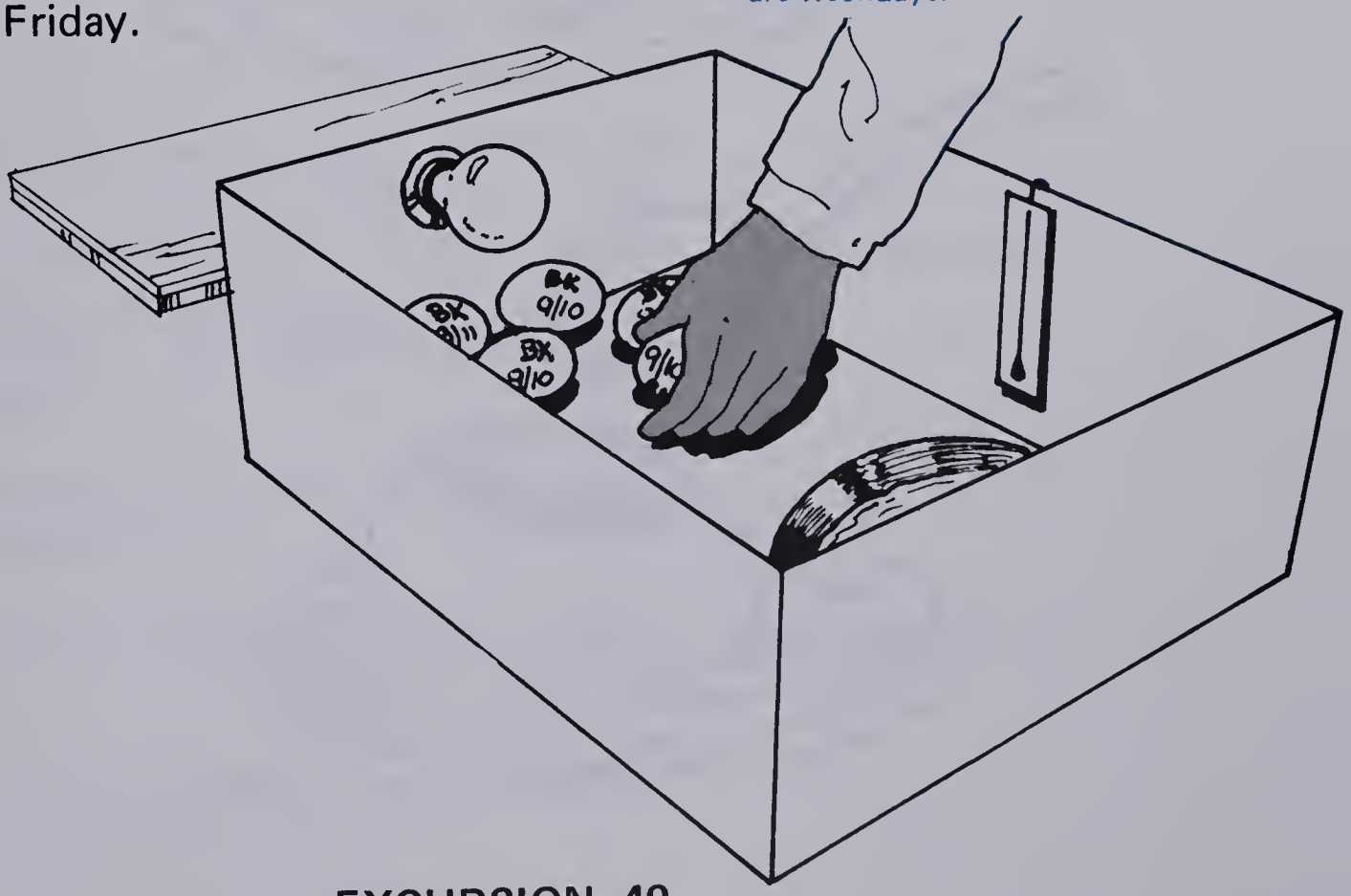
5 fertilized chicken eggs
grease pencil
incubator containing Celsius thermometer and pan of water
4 baby-food jars with lids
isopropyl alcohol
petri dish
cotton batting or sponge
dissecting scissors
forceps
plastic spoon
hand lens
food and water for baby chicks
2 pans for food and water

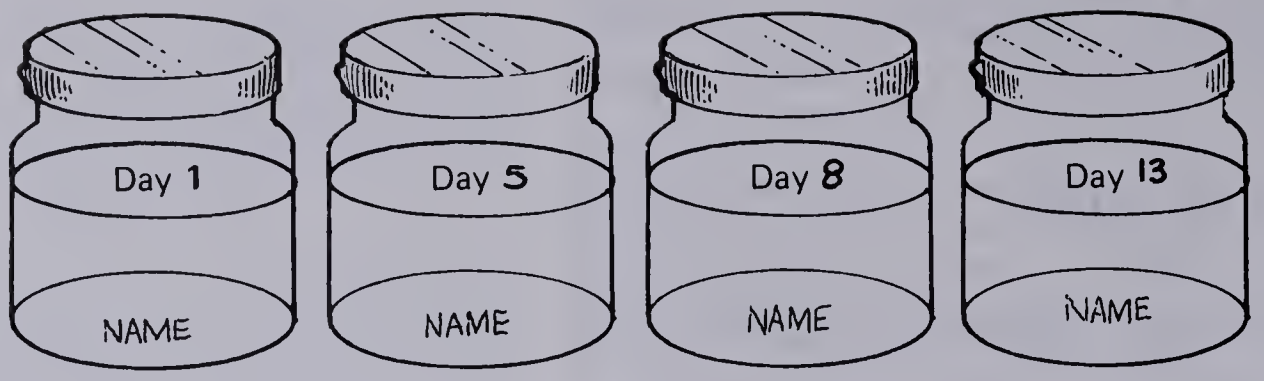
If you wish to have students examine the embryos more closely, have them carefully pour the alcohol and the egg from the jar into a culture dish. Then they can examine the embryo under a binocular dissecting microscope. When they have finished, the students should carefully return the embryo and the alcohol to the proper jar.

If today is Thursday or Friday, do Steps A through H. Otherwise, work on another activity or minicourse and return to this investigation on a Thursday or Friday.

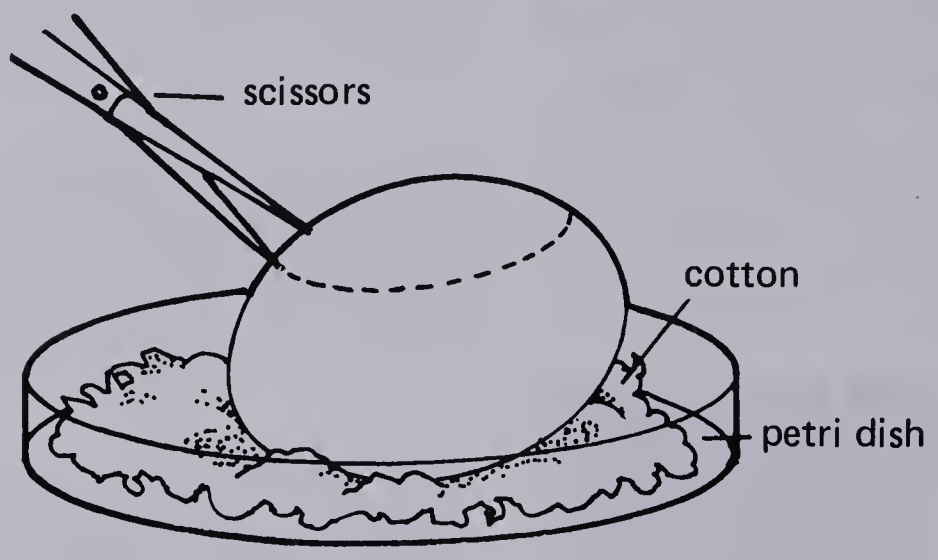
Beginning the incubation on a Thursday or Friday will insure that Days 1, 5, 8, 13, 19, and 21 are weekdays.

A. Begin this step on a Thursday or Friday only. With the grease pencil, carefully write the date and your initials on all five eggs. Put the five eggs into the incubator. The incubator must run continuously for twenty-one days. Each day, you must turn all of your eggs remaining in the incubator to their opposite side.



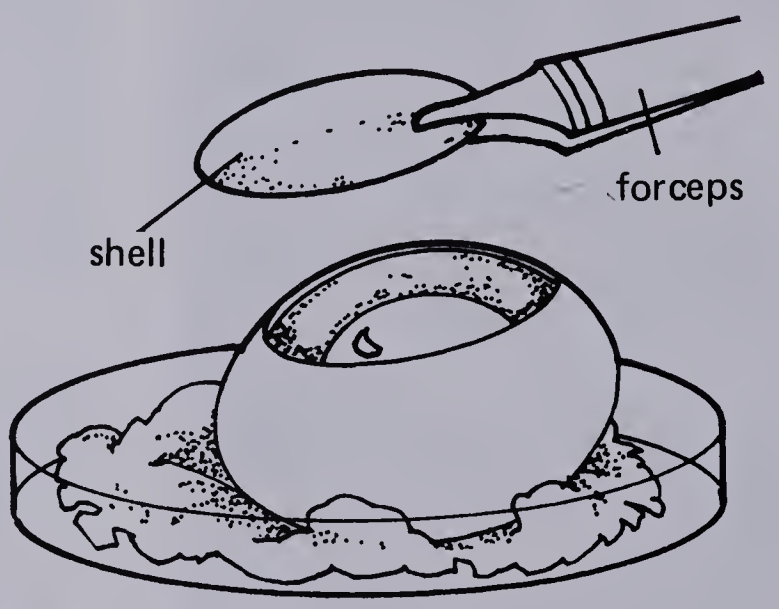


B. Using the grease pencil, label four baby-food jars *Day 1, Day 5, Day 8,* and *Day 13.* Also put your name or initials on each jar. Pour alcohol into the four jars so that they are half full. Tightly cover the jars with the lids.

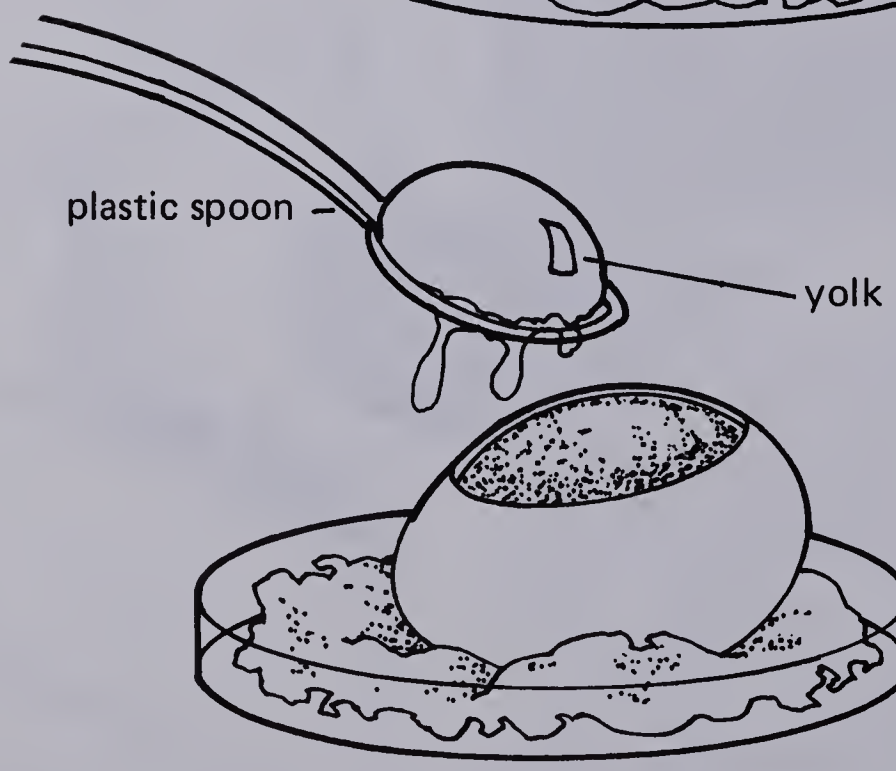


C. Line the petri dish with cotton batting. At the end of Day 1, take one egg out of the incubator. Place it in the petri dish. Turn the other eggs in the incubator to their opposite sides.

D. Carefully insert one point of the scissors into the egg. Just barely pierce the shell and the membrane. Cut all the way around the egg.

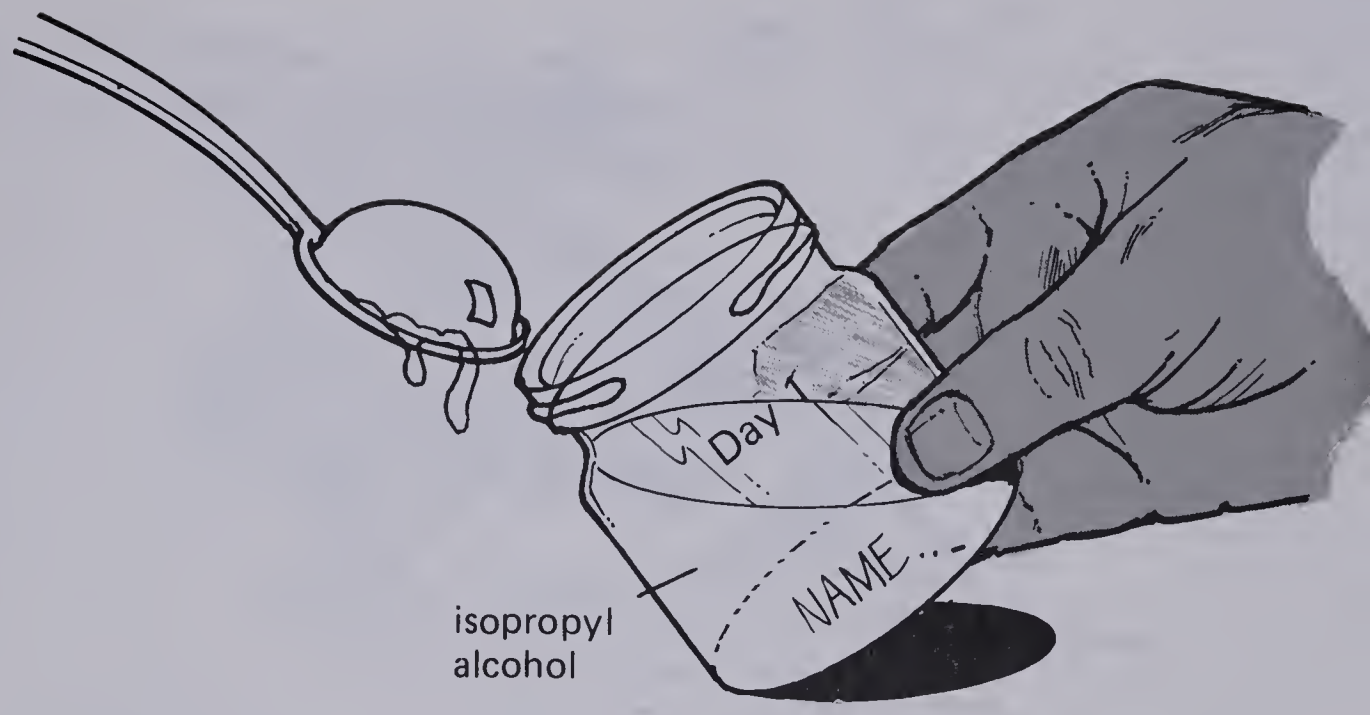


E. With forceps, carefully remove the loose shell and membrane.



F. Lift out the yolk very carefully with the spoon. Some of the white will probably come with the yolk.

G. Carefully slide the yolk into the jar of alcohol for Day 1. Be careful not to break the yolk.



H. Look for the red spot on the yolk. If you can't see it, carefully roll the yolk over with the plastic spoon. Be careful not to break the yolk. Observe the red spot, using the hand lens. If there is no red spot, tell your teacher. It may mean that the incubator is not working or that the egg cell was not fertilized.

The egg has two parts — the white and the yolk. Most of the yolk is stored food material for the embryo. The tiny red spot on the surface of the yolk contains many cells, which form the developing embryo. From these cells, additional cells will form as the embryo grows and develops. The heart and blood form during early stages of development.

● 13-1. Tell whether the following statement is true or false. The yolk provides food for the embryo.

13-1. True

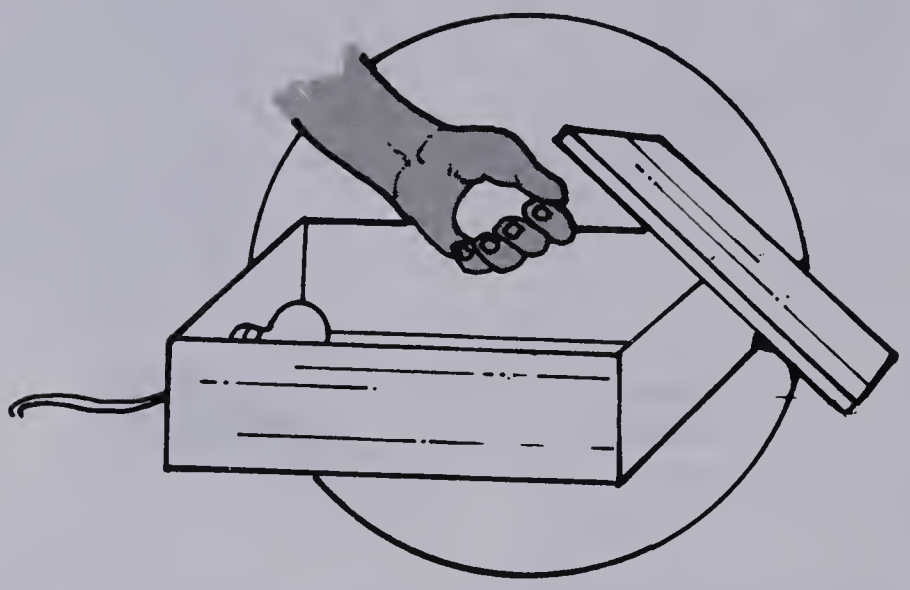
● 13-2. From what do both human and chicken embryos begin developing?

13-2. A fertilized egg cell

● 13-3. Which organ of the chicken embryo is one of the first organs to form?

13-3. The heart

Now work on another activity until Day 5. Remember to turn the eggs in the incubator every day. At the end of Day 5, do Step I.



I. At the end of Day 5, take a second egg out of the incubator. Using the procedure described in Steps C through G, open the egg. Use the hand lens to observe the embryo, as in Step H.

13-4. The head

● 13-4. Which part of the chicken embryo seems to be unusually large and the first to develop — the head, the wings, or the legs?

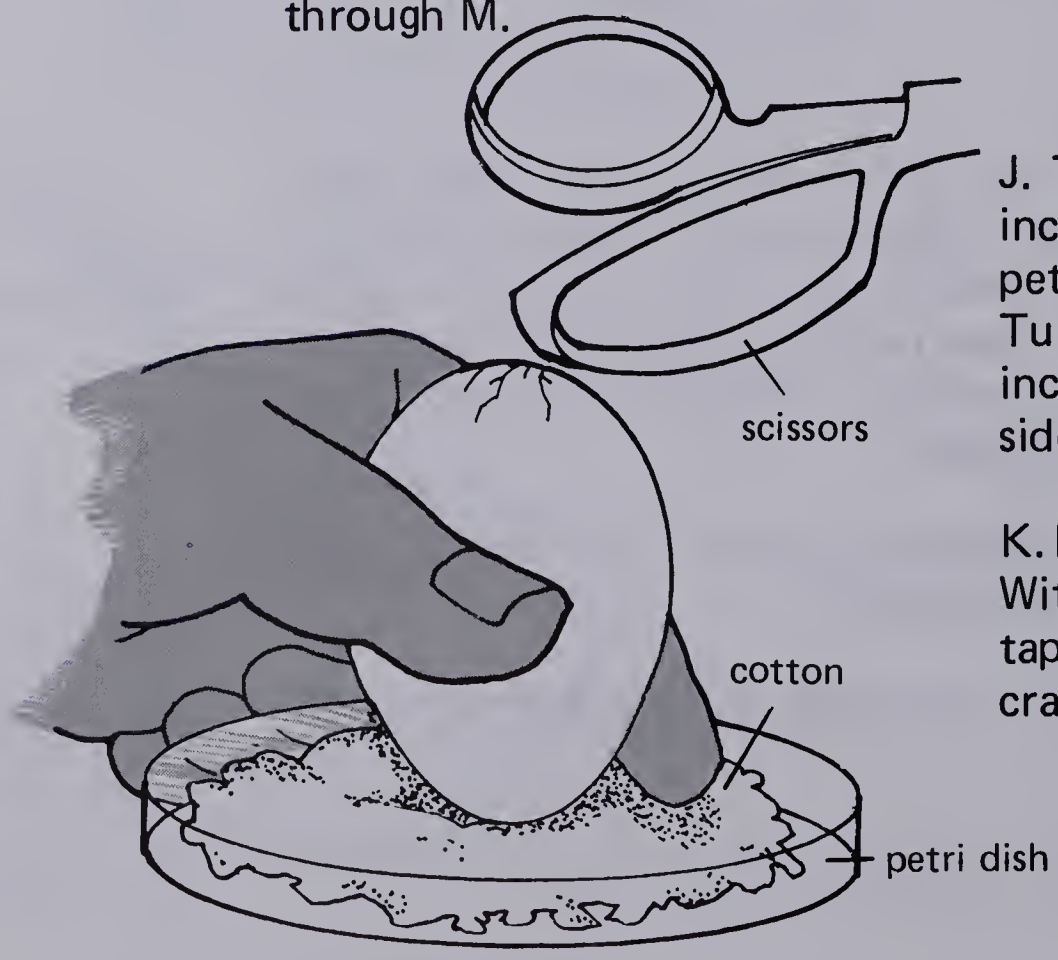
13-5. The head

● 13-5. Which part of a human embryo do you think would be unusually large and the first to develop? (You may want to refer to the pictures of human embryos in Activity 4.)

13-6. Head, trunk (main part of body), tail, wings, leg buds, and perhaps the eyes

● 13-6. Which parts of the chicken embryo can you identify on Day 5?

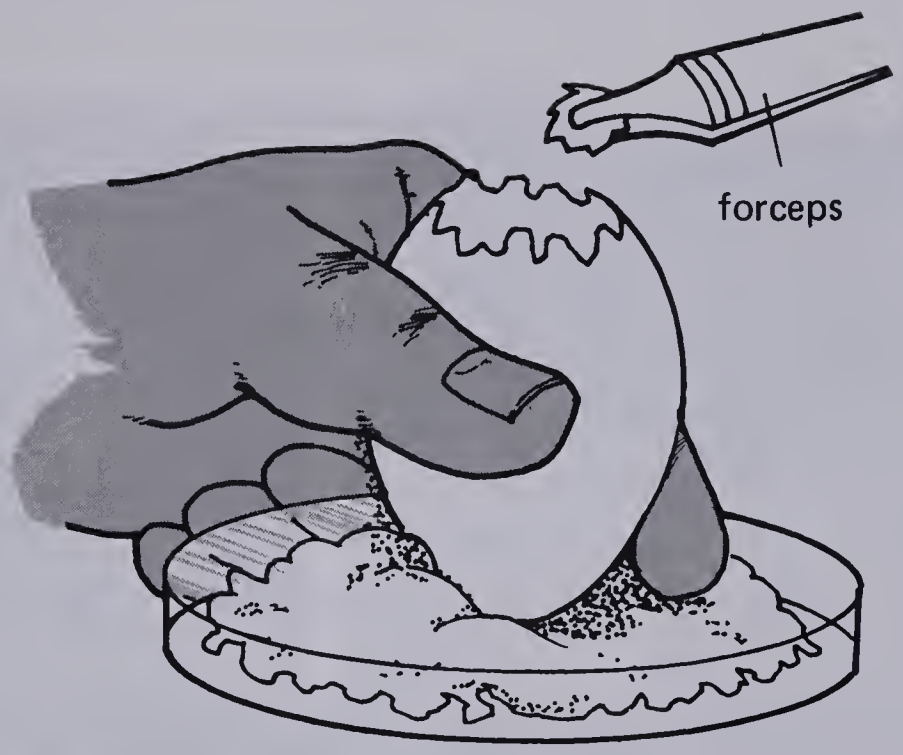
Work on another activity until Day 8. Be sure to turn the eggs in the incubator every day. At the end of Day 8, do Steps J through M.



J. Take one egg out of the incubator. Place it in the petri dish lined with cotton. Turn the other eggs in the incubator to their opposite sides.

K. Hold the egg, large end up. With the handle of the scissors, tap the shell gently until it cracks.

L. Remove the pieces of shell from the top of the egg. Using the scissors, carefully cut away the membrane.



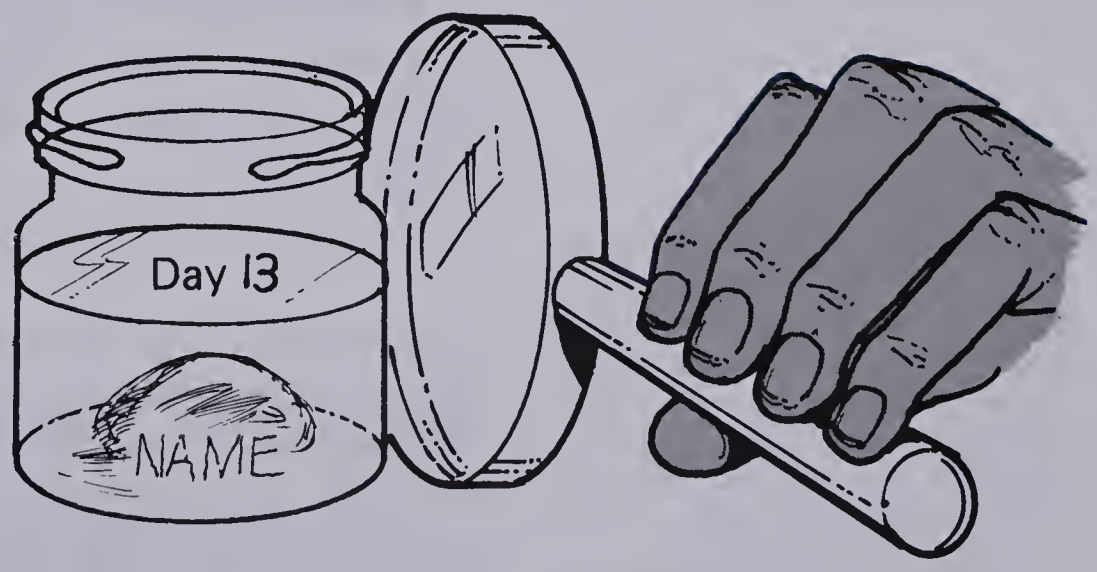
M. Very gently slide the contents of the shell into the jar of alcohol for Day 8. Use the hand lens as before to observe the embryo.

● 13-7. Compare the embryo for Day 8 with the embryo you observed on Day 5. What changes can you see in the head, wings, and legs of the embryo?

13-7. The head has developed large eyes, ears, and a beak. "Fingers" have appeared on the wings, and "toes" have appeared on the feet.

Once again, work on another activity, but be sure to turn the eggs in the incubator every day. At the end of Day 13, do Step N.

N. At the end of Day 13, remove the fourth egg from the incubator. Using the procedure described in Steps J through M, open the egg. Use the hand lens to observe the embryo as before.



13-8. In comparison with each other, the head becomes smaller and the legs become larger; yes.

☆ **13-8. As the chicken embryo continued to develop, how did the size of its head and legs change in relation to each other? Do you think this is also true of a developing human embryo?**

Students will want to observe the hatching without startling the chickens. A piece of glass could be substituted for one of the boards on top of the incubator.

CAUTION	You may not be present when the fifth egg hatches. So, on Day 19, put small pans of drinking water and food inside the incubator.

Work on another activity, but remember to turn the remaining egg in the incubator every day. On Day 21, do Step O.

O. On Day 21, watch the chick hatch from the fifth egg. Do not remove the egg or the chick from the incubator.

13-9. C, A, B, D

☆ **13-9. The following are events in the development of a chicken embryo. Arrange the events in the order in which they occur.**

A. The heart forms, and the head is relatively large.
B. The legs and wings appear.
C. There is a single fertilized egg.
D. The head seems relatively smaller compared with other body parts.

ACTIVITY EMPHASIS: Identical twins or triplets develop from a single fertilized egg. Fraternal twins or triplets develop from multiple fertilized eggs. The probability of having twins is related to the age, the race, and other factors of the mother.

MATERIALS PER STUDENT LAB GROUP: None

ACTIVITY 14: TWINS AND TRIPLETS

Some twins look alike, and some don't. Some twins are called *identical* twins, and some are called *fraternal* twins. Figure 14-1 (page 55) shows some sets of identical and fraternal twins.

Figure 14-1

Every once in a while, a single fertilized egg will separate during its very early stages of development. Each half of the clump of cells will develop into a baby. The two babies are identical twins.

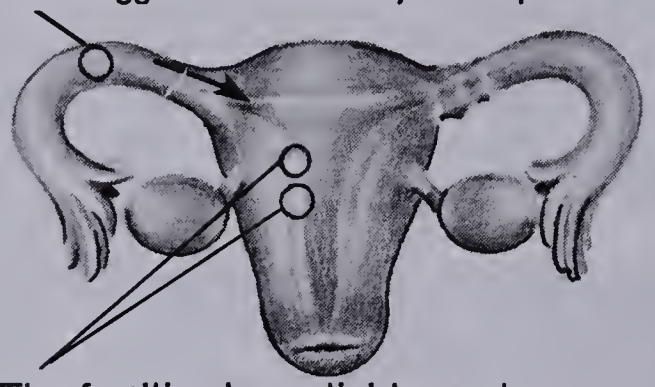
Because they both came from the same fertilized egg, identical twins are always the same sex. And they are usually very similar in appearance and physical abilities. (At the time of fertilization, sex and many physical characteristics are determined.) But just like everyone else, identical twins may develop different interests and personalities. Of course, they may have very similar interests if they are together much of the time as they grow up.

Sometimes two separate eggs are released and are fertilized at the same time. Each fertilized egg will develop into a baby. The two babies are fraternal twins.

Because they came from two different fertilized eggs, fraternal twins may be the same sex or different sexes. They are only as similar in appearance and physical abilities as any two children are in the same family. Figure 14-2 below shows two steps in the development of identical and fraternal twins and the possible results.

IDENTICAL TWINS

1. One egg is fertilized by one sperm.



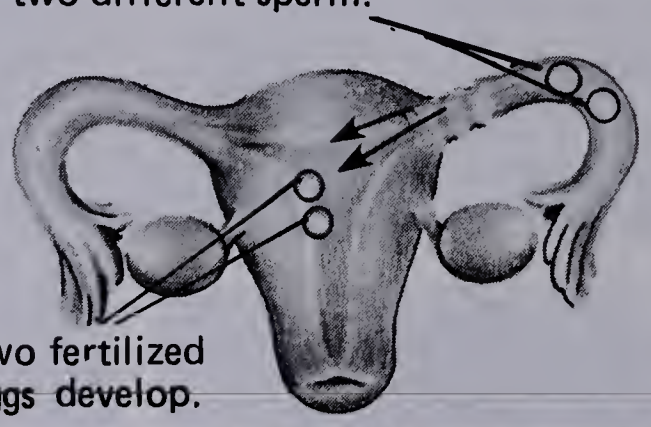
2. The fertilized egg divides and separates into two.

1st possibility

2nd possibility

FRATERNAL TWINS

1. Two different eggs are fertilized by two different sperm.



2. Two fertilized eggs develop.

1st possibility

2nd possibility

3rd possibility

Figure 14-2

● 14-1. Which type of twins — identical or fraternal — can be as different as any brothers and sisters born at different times?

14-1. Fraternal twins

● 14-2. A woman has twins — a boy and a girl. Which type of twins are they?

14-2. Fraternal twins

● 14-3. Why are identical twins very similar in appearance?

14-3. They develop from the same fertilized egg (the same set of chromosomes).

☆ **14-4. Name and describe two different ways that twins can develop.**

14-4. From one fertilized egg that separates to form two identical parts (resulting in identical twins); from two different fertilized eggs (resulting in fraternal twins)

Certain drugs are sometimes given to women who want to increase the chances of fertilization occurring. These drugs can cause several eggs to be released, instead of just one. Then, the woman gives birth to fraternal twins, triplets, or even more babies.

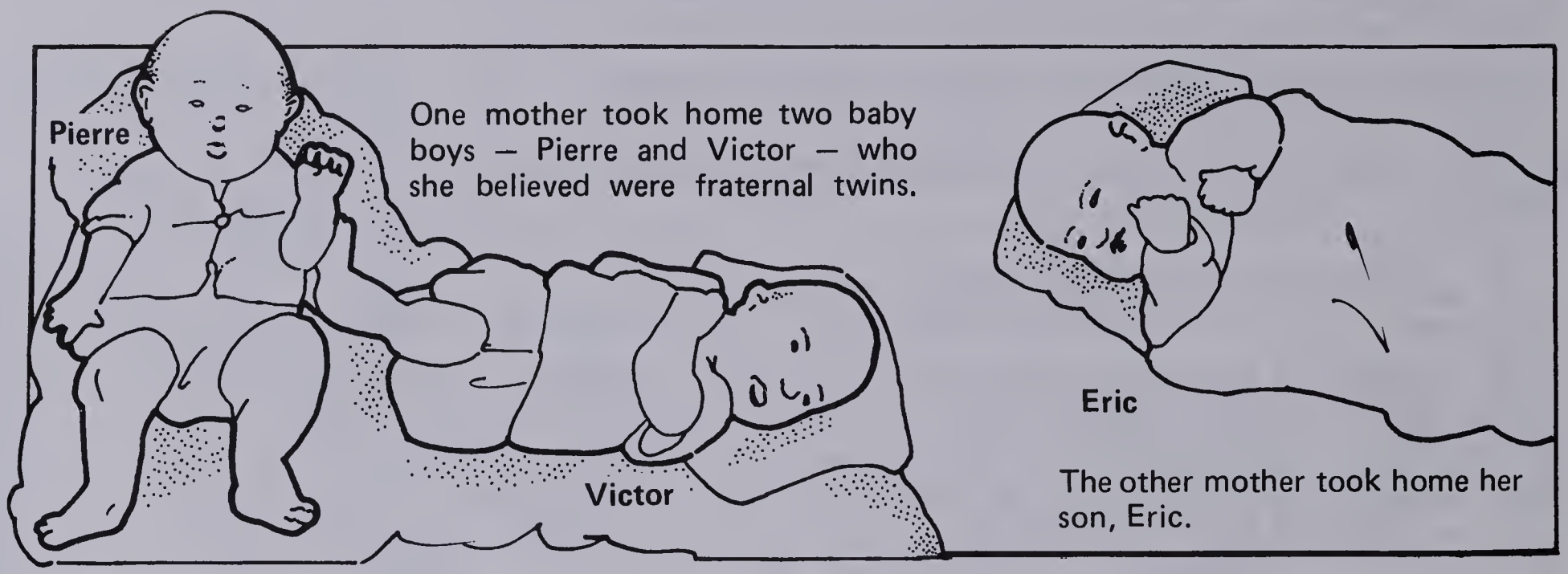
Triplets can develop in several different ways. All three babies may come from one fertilized egg. Each of the three babies may come from a separate fertilized egg. Two of the babies may come from one fertilized egg as identical twins, and the third baby may come from a separate fertilized egg as a fraternal twin.

● 14-5. Look at the triplets shown below. What possible combination of fertilized eggs did they probably come from?

14-5. Probably from three different fertilized eggs

Identical twins or triplets are basically the same person in terms of body chemistry. So organ and tissue transplants between twins usually take and are not rejected by the body. In fact, the ability to accept skin grafts from another body is one way to test for true identical twins. This was actually used once in a case in Switzerland, as shown on page 58.

Two women in the same town went to the same hospital to have their babies.



One mother took home two baby boys – Pierre and Victor – who she believed were fraternal twins.

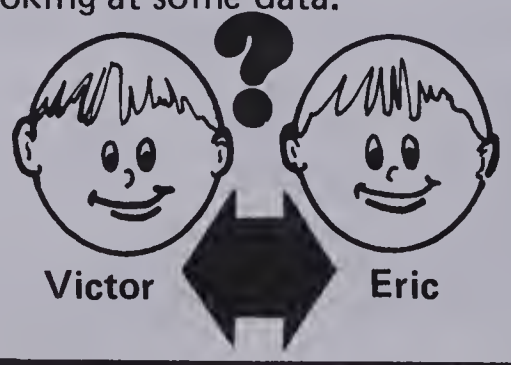
The other mother took home her son, Eric.

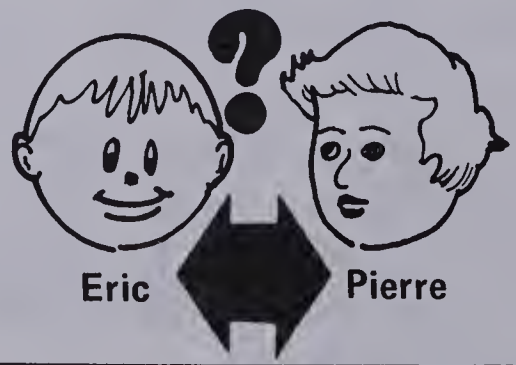
When they were about six years old, someone noticed that Eric and Victor looked alike.

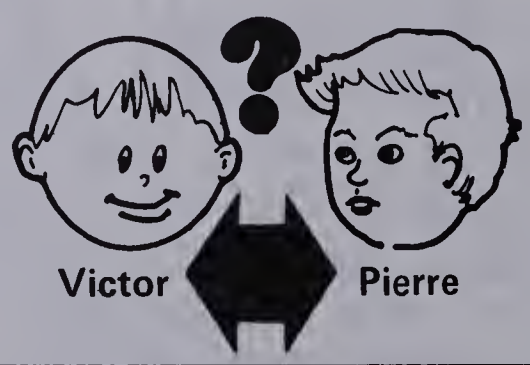
Had Pierre and Eric been taken home by the wrong mothers? Could Eric and Victor possibly be identical twins?

To find out, a doctor performed skin grafts on the three boys.

The results of the grafts solved the mystery. The real twins went home to their parents, and the third boy went with his parents. Now, see whether you can solve the mystery by answering a few questions and looking at some data.







● 14-6. What would be the probable results of a skin graft between unrelated people? Between identical twins? Between fraternal twins?

14-6. Rejected; accepted; rejected

● 14-7. If Victor and Eric were identical twins, what would probably happen to the skin grafts among the three boys?

14-7. Victor's body should accept the skin graft from Eric, and Eric's body should accept the graft from Victor. Pierre's skin graft would be rejected by both Victor and Eric, and Pierre's body would reject the graft from either Victor or Eric.

● 14-8. If Pierre and Victor were fraternal twins and Eric was not related to them, what would probably happen to the skin grafts?

14-8. None of their bodies would accept any of the grafts.

The data in Figure 14-3 below show the results of the skin-graft experiment.

GIVER OF SKIN	RECEIVER OF SKIN GRAFT	RESULTS OF SKIN GRAFT
Eric	Victor	accepted
Victor	Eric	accepted
Pierre	Victor	rejected
Victor	Pierre	rejected
Pierre	Eric	rejected
Eric	Pierre	rejected

Figure 14-3

● 14-9. According to the data in Figure 14-3 above, which two boys were actually identical twins?

14-9. Victor and Eric

The chances of a woman giving birth to two or more babies at once depend on several factors. These factors include race, the number of previous children (single and multiple births), age, and the family's tendencies toward twinning.

The table in Figure 14-4 below shows the frequency of births of twins in several countries. The graph in Figure 14-5 (page 60) shows the percentage of births of twins in the United States to black mothers and to white mothers.

COUNTRY	AVERAGE NUMBER OF TWIN BIRTHS PER 1000 BIRTHS
Japan	7.0
China	8.0
United States (whites)	9.4
United States (blacks)	13.7
Nigeria	45.0

Figure 14-4

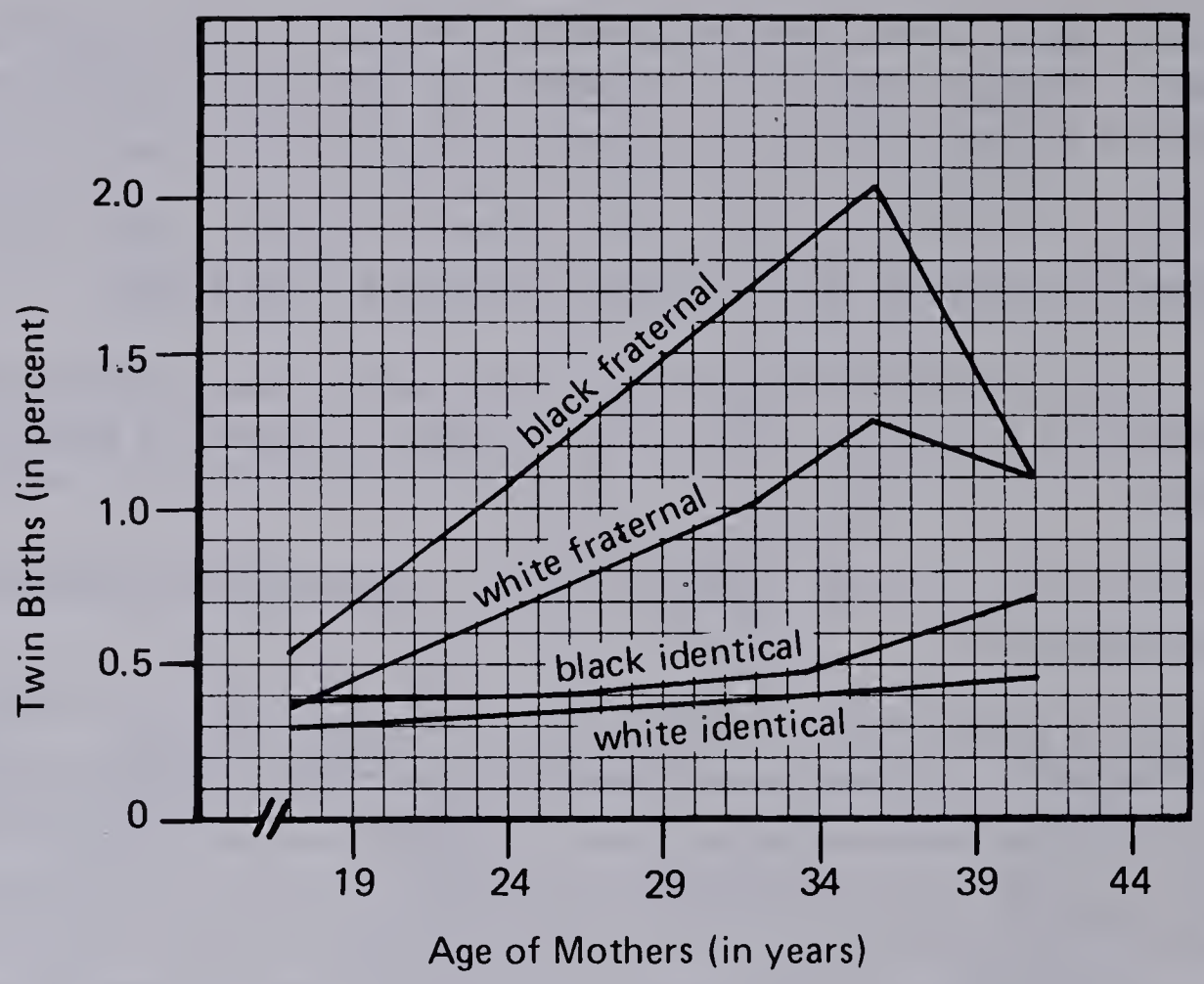


Figure 14-5

14-10. To black women

● 14-10. According to the graph in Figure 14-5 above, are twins born more often to white women or to black women?

14-11. D, B, C, A

● 14-11. Rank these four women in order from most likely to least likely to give birth to fraternal twins.
A. White woman, 20 years old
B. White woman, 40 years old
C. Black woman, 20 years old
D. Black woman, 35 years old

14-12. Births of fraternal twins

☆ **14-12. Which occur more often — births of identical twins or births of fraternal twins?**

ACTIVITY 15: BIOLOGICAL FAMILY PLANNING

ACTIVITY EMPHASIS: Information concerning biological family planning methods — abstention, withdrawal, and rhythm — are provided.

MATERIALS PER STUDENT LAB GROUP: None

Most people think that it's important for a baby to be wanted. And most couples think that it's better to rear the number of children they want when they can provide a home, food, and loving care for them. In other words, they want to plan the number of children they'll have. And they want to plan the times in their lives when their children should arrive. That's called *family planning.*

The methods of family planning you'll learn about in this activity are called *biological*. That means no devices or chemicals are used in the methods. (Activity 16 explains family planning methods that require different devices or chemicals.)

To understand family planning methods, you'll need to review how an egg is fertilized. During sexual intercourse, millions of sperm from the male are released into the vagina of the female. A mature egg may be fertilized if it is in a fallopian tube when sperm are also in the tube. Look at Figure 15-1 below.

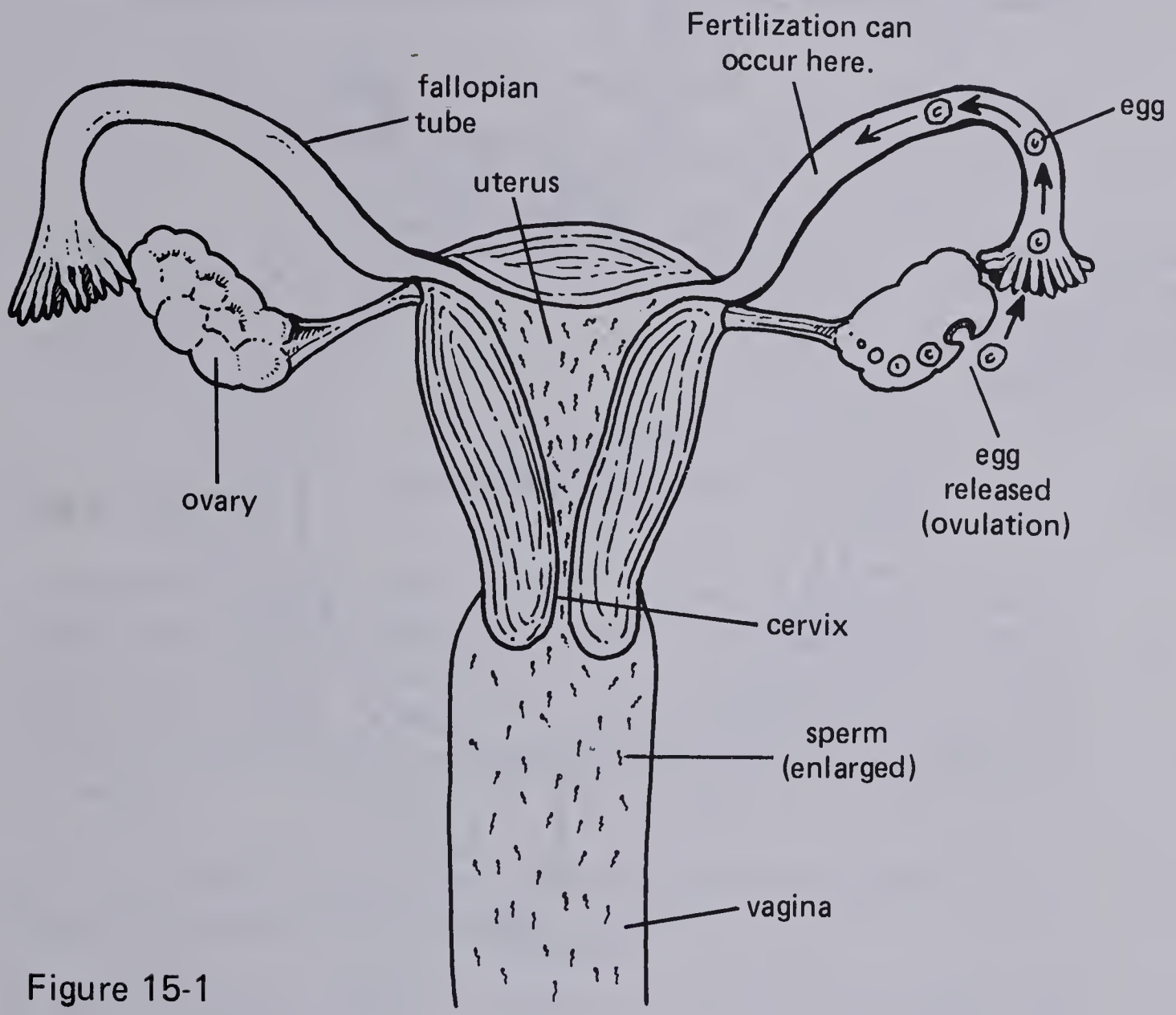


Figure 15-1

● 15-1. Normally, if fertilization is to occur, where must a sperm meet a mature egg?

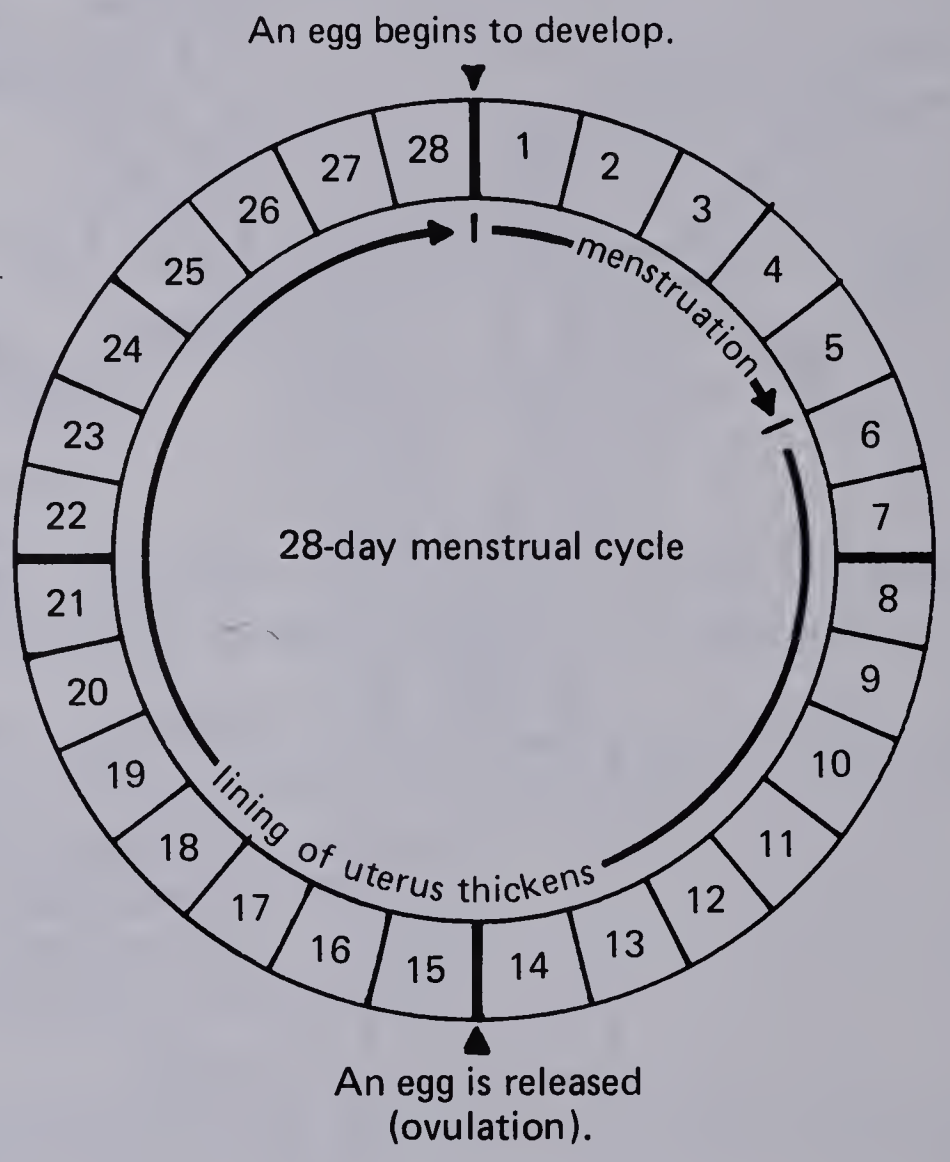
15-1. In a fallopian tube

Biological methods of family planning are used for two purposes. They are used by couples to conceive a child at the time they wish. And they are used to avoid pregnancies when they are not wanted.

One method of family planning is obvious. It is totally avoiding sexual intercourse except when a pregnancy is wanted. That method is, of course, one hundred percent effective in avoiding unwanted pregnancies.

Another method is to remove the penis from the vagina before sperm are released during sexual intercourse. This method is not highly successful in avoiding pregnancies because small amounts of semen are often released early in intercourse. And only one sperm cell is necessary to fertilize an egg.

But, as you learned in the core activities, there is only a certain time during the menstrual cycle when a mature egg is in a fallopian tube. Halfway through the cycle a mature egg is released from an ovary. That is called *ovulation*. Look at Figure 15-2 below. It shows the date of ovulation for a twenty-eight-day cycle.



This diagram is based on a normal, nonvarying, twenty-eight-day menstrual cycle.

Figure 15-2

15-2. Day 14; Day 15; Day 13

● 15-2. On what day does ovulation occur in a normal, twenty-eight-day cycle? In a normal, thirty-day cycle? In a normal, twenty-six-day cycle?

A third method of family planning is based on the ovulation date. It is called the *rhythm method*.

In the rhythm method, a couple not wanting a pregnancy must avoid sexual intercourse during certain times around ovulation. A couple wanting a pregnancy would have sexual intercourse during those days when conception can occur.

If pregnancy is to be avoided, sperm must not be released in the vagina from two days before the egg is released to three days after the egg is released. A sperm can fertilize an egg up to two days after sexual intercourse. Sperm can remain active in the uterus and fallopian tubes for up to two days. So, even if there is no mature egg in the fallopian tube when the sperm arrive, fertilization is still possible if the egg arrives within two days. Look at Figure 15-3 below.

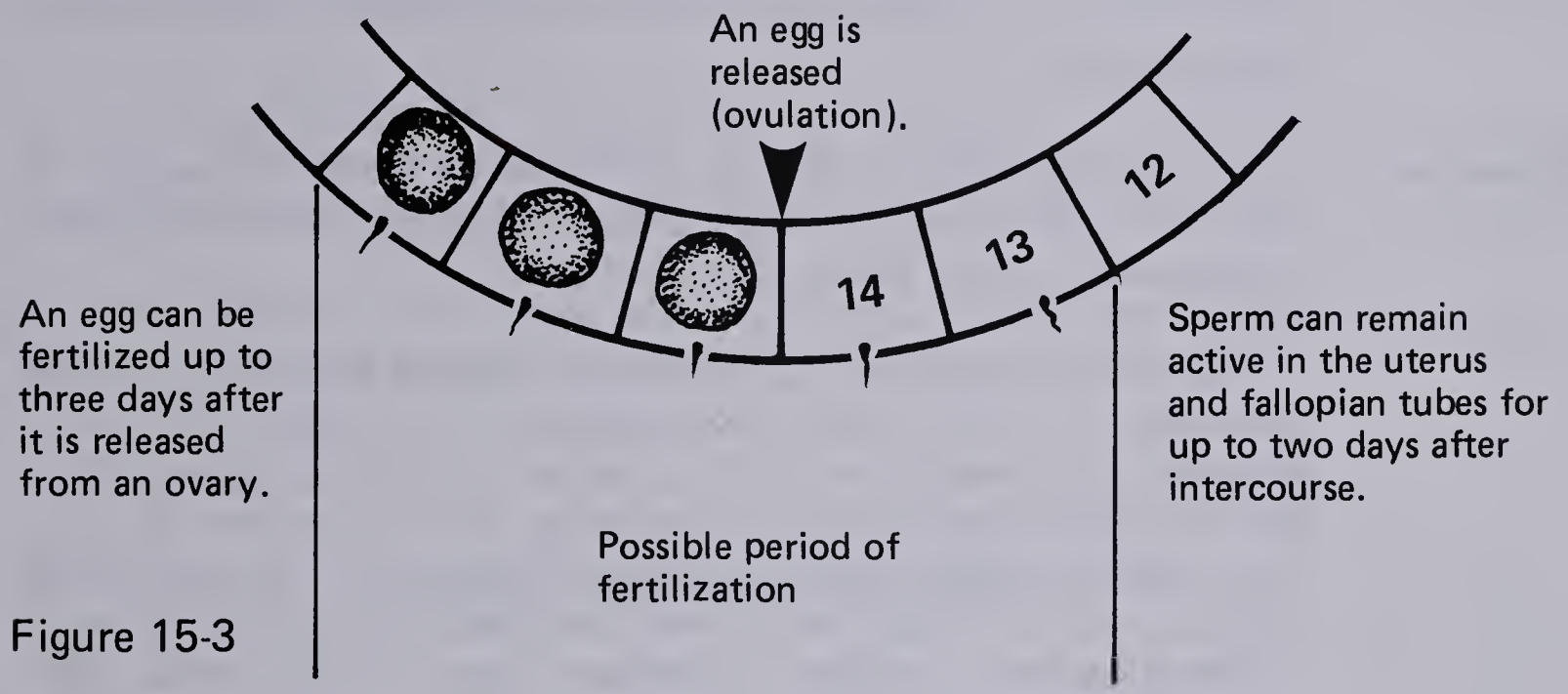


Figure 15-3

Once the egg has been released, it remains active for up to three days. If active sperm are present, fertilization is possible, then, for three days following ovulation. As Figure 15-3 above shows, this results in a period of about five days during each menstrual cycle when fertilization is possible and pregnancy can result.

● 15-3. How long after sexual intercourse can sperm remain active in the uterus and fallopian tubes?

15-3. Up to two days

● 15-4. How long after it is released from the ovary is an egg able to be fertilized?

15-4. Up to three days

Thus, if a couple wants to avoid a pregnancy, there must be no sexual intercourse for about two days before and about three days after the expected ovulation day. If the couple wants a pregnancy, those days are the days on which conception can occur.

For the rhythm method to be used effectively, the date of ovulation must be known. Once this is known, then counting about two days before and about three days after this date will determine the days of possible fertilization and pregnancy. But it is hard to pinpoint the exact time of ovulation. It can vary somewhat even in women who have very regular cycles.

Now look at the effectiveness of the three biological methods of family planning. Figure 15-4 below shows the percentage of women who will become pregnant using each method.

METHOD	PERCENTAGE OF PREGNANCIES
No sexual intercourse	0
Removal of penis before sperm are released	20 to 30
Rhythm	20 to 30

Figure 15-4

15-5. 20% to 30%; 20% to 30%

● 15-5. According to Figure 15-4 above, what percentage of women will get pregnant when the penis is removed before sperm are released? Using the rhythm method?

The rhythm method is, in theory, a sound method of family planning. It can control pregnancies if ovulation occurs on schedule and sexual intercourse does not occur around ovulation. But the menstrual cycle and ovulation of one woman in six is too irregular for the rhythm method to be used. A variation in ovulation of even one day either way may result in pregnancy.

Some variation in the menstrual cycle occurs quite often among most women. And this creates problems in determining the time of ovulation. Some women have found that on the day of ovulation their body temperature rises very slightly. It remains at this higher level until the beginning of menstruation. Then the temperature drops until the next date on which ovulation occurs.

A daily record of temperatures taken upon arising and a record of beginning dates of menstruation may be helpful in determining the time of ovulation. Then a chart of a cycle, such as those shown in Figure 15-5 below, can be developed.

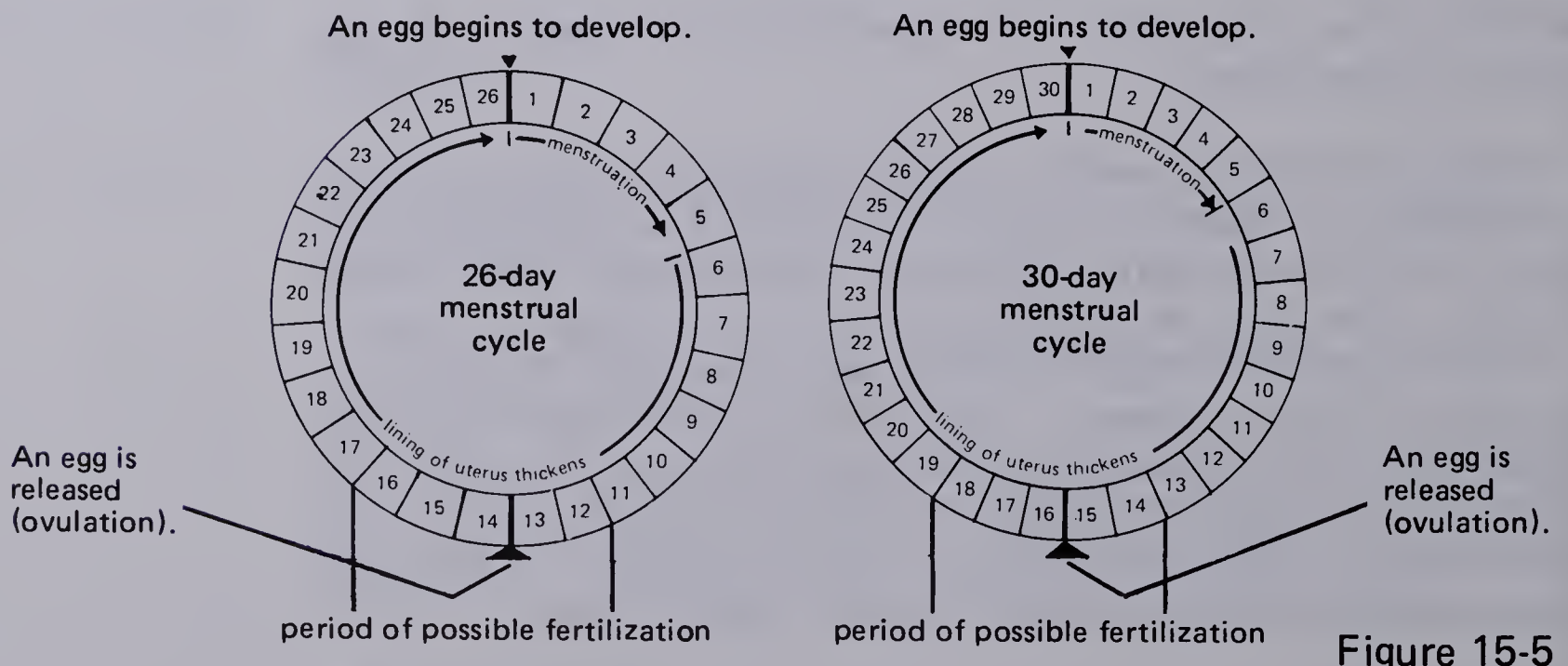


Figure 15-5

● 15-6. Suppose a woman has a normal, regular, twenty-eight-day menstrual cycle. For how many days in each cycle should she avoid sexual intercourse to prevent pregnancy?

15-6. About 5 days

☆ **15-7. Suppose a woman who has a normal, regular, thirty-day menstrual cycle wants to conceive. On which days should sperm be received?**

15-7. Between Days 14 and 18

● 15-8. Suppose that same woman's cycle begins on April 1. On approximately which date will ovulation occur?

15-8. About April 15 or 16

● 15-9. Suppose the cycle of that same woman begins on November 15. On approximately which date will ovulation occur? On which dates may fertilization occur?

15-9. About November 30 or December 1; about November 28 to December 3

☆ **15-10. What is the most important factor that affects the successful use of the rhythm method?**

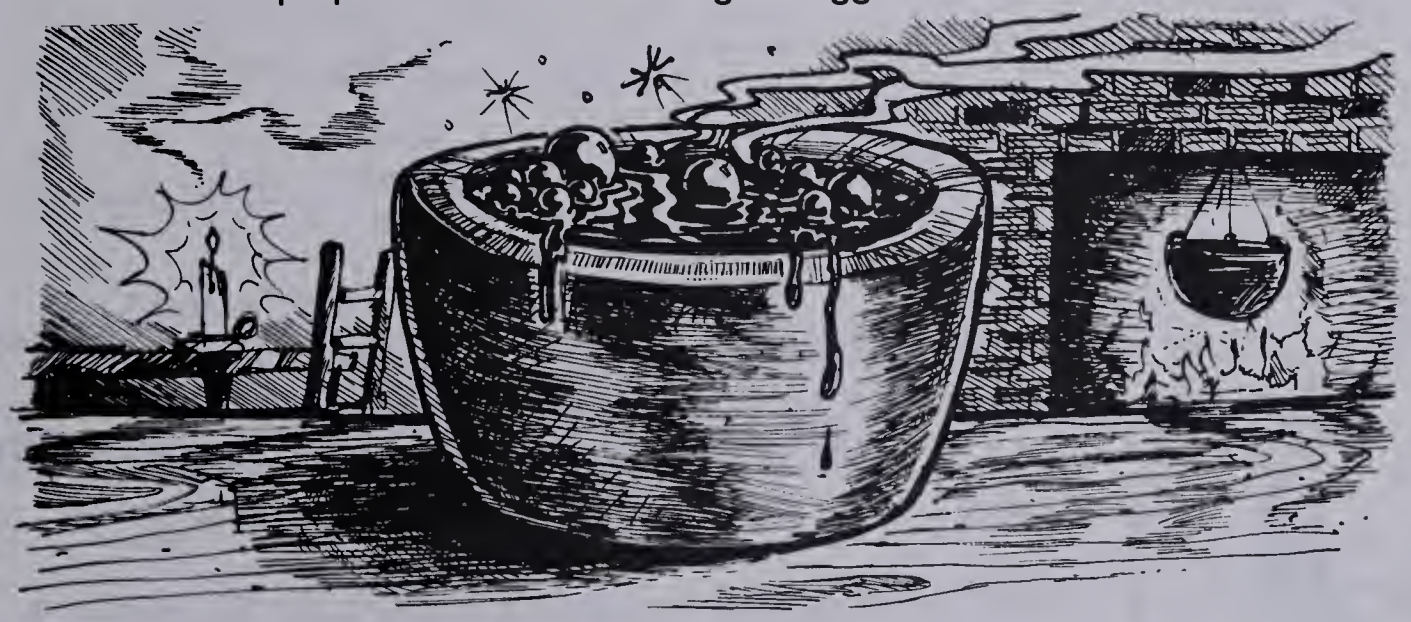
15-10. The regularity of ovulation

ACTIVITY 16: FAMILY PLANNING METHODS

ACTIVITY EMPHASIS: Current, effective, mechanical and chemical methods of birth control include the diaphragm and jellies, the IUD, spermicides, birth-control pills, the condom, and surgical sterilization.

MATERIALS PER STUDENT LAB GROUP: None

For hundreds of years, people have tried various methods to prevent pregnancies. They've used herbs and brews and devices made to stop sperm from reaching an egg.



Several different methods of preventing pregnancies are available today. This activity discusses both mechanical methods and chemical methods of birth control. (Activity 15 discusses family planning methods that require no devices or chemicals.)

Most of the methods discussed in this activity require instructions and a prescription from a doctor. Many clinics and organizations provide advice and counseling about birth control. Such advice can help couples to have the number of children they want when they want them.

Fertilization occurs at the moment a sperm penetrates an egg cell. The objective of any birth-control method is to prevent this union from occurring. Figure 16-1 below lists the birth-control methods discussed in this activity. It also shows the percentage of women who will become pregnant while using each method.

METHOD OF BIRTH CONTROL	PERCENTAGE OF PREGNANCIES
Diaphragm and jelly	10 to 20
IUD	1 to 8
Sperm-killing chemicals	15 to 25
Pill	0.5 to 2
Condom	10 to 15
Tube cutting	almost 0

Figure 16-1

There are several different types of birth-control methods for females. One of the most common is the diaphragm, a mechanical device.

A diaphragm is a rubber, cup-shaped device. It is put into the vagina before sexual intercourse. It blocks the opening of the uterus and prevents sperm from entering. Figure 16-2 below shows a diaphragm in the proper position.

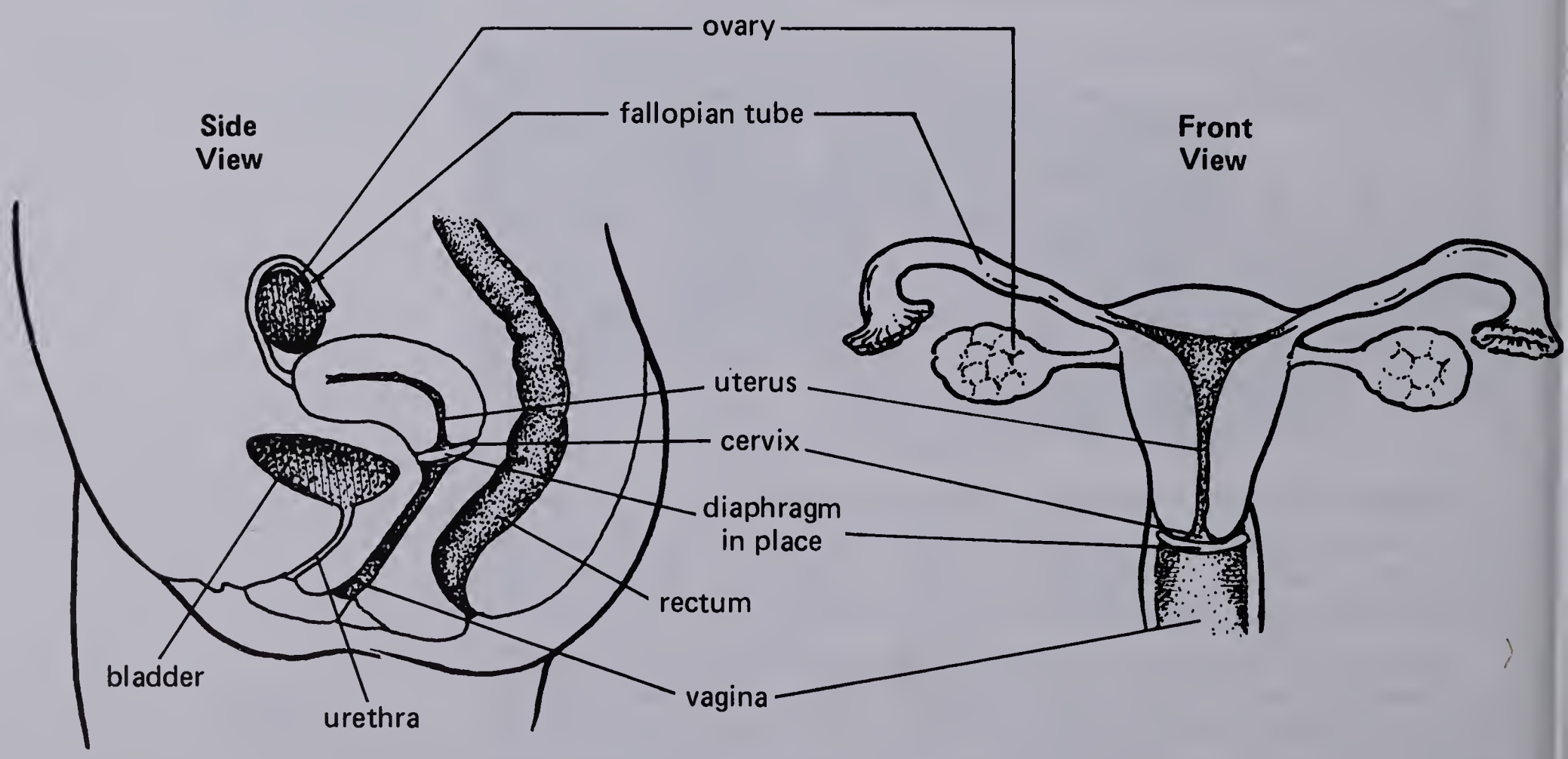


Figure 16-2

A diaphragm is usually used with a chemical, sperm-killing jelly. The jelly also helps to prevent fertilization. A diaphragm must be properly fitted by a doctor. The doctor must give instructions for its use.

● 16-1. According to Figure 16-1 (page 66), what is the percentage of pregnancies when a diaphragm and jelly are used?

16-1. 10% to 20%

The IUD (intrauterine device) is another mechanical birth-control device. It is a small piece of plastic or metal. IUDs come in many different shapes. Figure 16-3 below shows an IUD in place in the uterus.

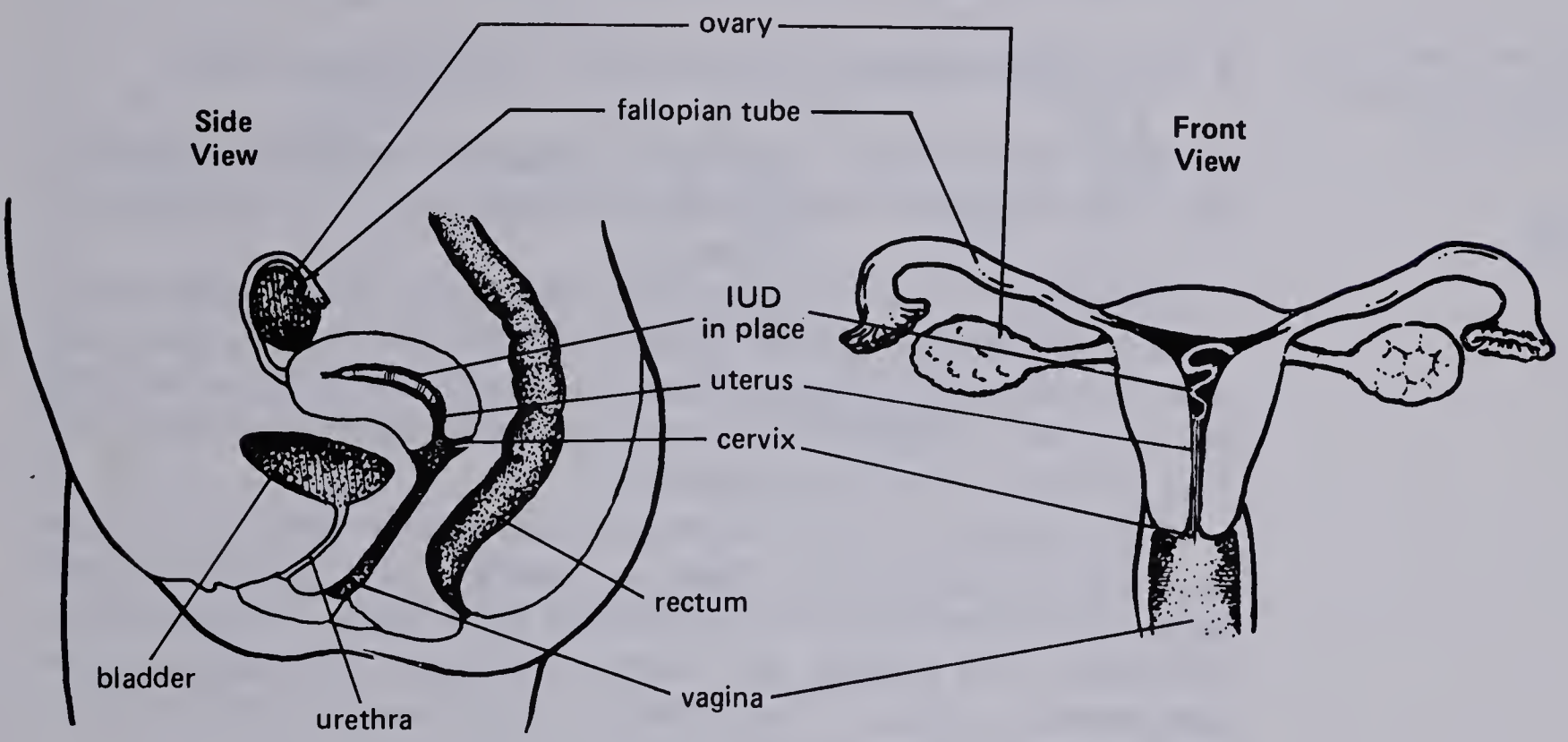


Figure 16-3

The IUD is put into the uterus by a doctor. It can remain in place for long periods of time. It must be checked at least once a year. It may be removed by a doctor if the woman wishes to get pregnant. The actual way by which pregnancy is prevented with the IUD is unknown.

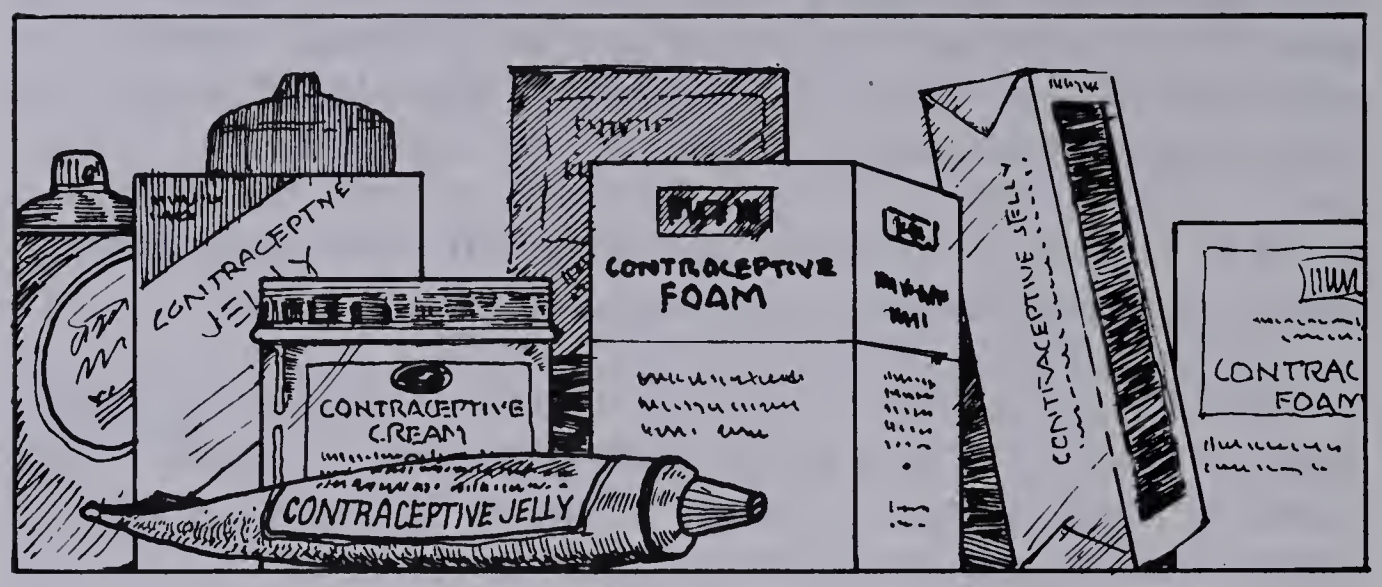
● 16-2. According to Figure 16-1 (page 66), what is the percentage of pregnancies when an IUD is used?

16-2. 1% to 8%

● 16-3. How is pregnancy prevented by an IUD?

16-3. The actual way is not known.

Sperm-killing creams, jellies, or foams are also used alone for birth control. The material is put into the upper vagina by means of an applicator before sexual intercourse. Chemicals in the material kill sperm cells and block the sperm from entering the uterus.



16-4. By killing sperm and blocking the entrance to the uterus so that sperm cannot enter

- 16-4. How do sperm-killing creams prevent pregnancies?

16-5. 15% to 25%

- 16-5. According to Figure 16-1 (page 66), what is the percentage of pregnancies when sperm-killing creams or jellies are used?

Sperm-killing creams, jellies, and foams are usually available in a drugstore without a prescription. They should not be confused with the sprays and foams used for cleanliness. Those are also available in a drugstore, but they are not birth-control materials. They will not prevent pregnancies.

Birth-control pills for women are very commonly used today to prevent pregnancies. There are several types of birth-control pills, all of which must be prescribed by a doctor. Most contain chemicals that change the normal hormone levels involved in the menstrual cycle. (See Activity 7 if you want to review information about hormones.)

Some types of pills prevent ovulation – the release of the egg – from occurring. There can be side effects from the pills. The doctor needs to know the medical history and physical condition of a woman in order to prescribe the type that will be best for her.

● 16-6. According to Figure 16-1 (page 66), what is the percentage of pregnancies when birth-control pills are used?

16-6. 0.5% to 2%

There is only one mechanical birth-control device for males that is widely used today. It is the condom, sometimes called a *rubber*. Figure 16-4 shows a condom rolled up, as it is in the package. It is unrolled for use.

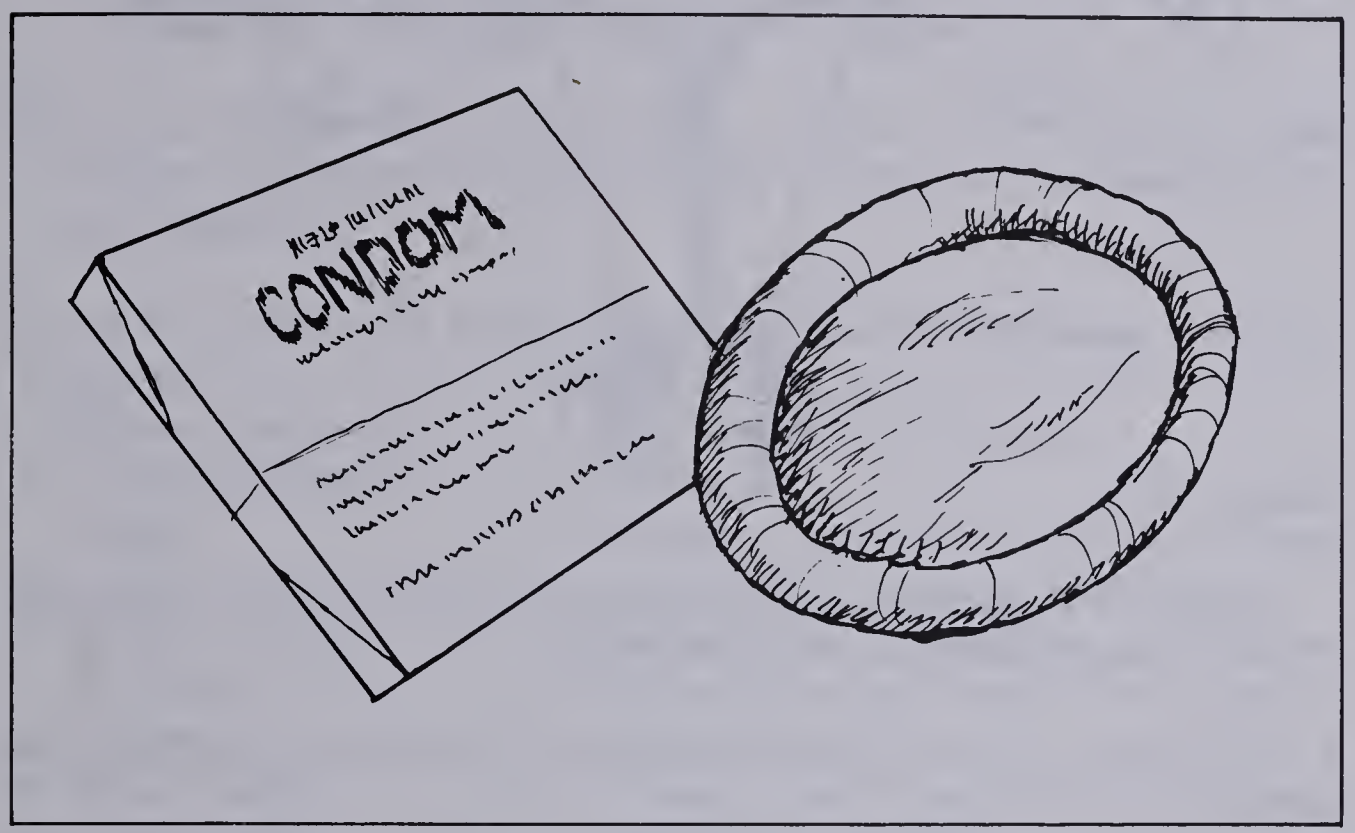


Figure 16-4

The condom is a saclike, elastic covering for the penis. It is used during sexual intercourse. It holds the released sperm and keeps them from going into the vagina. Even a tiny hole or tear will keep a condom from being effective in birth control. Condoms are available without a prescription at most drugstores.

● 16-7. How is pregnancy prevented by a condom?

16-7. Sperm are held in the condom and, therefore, cannot enter the vagina.

● 16-8. According to Figure 16-1 (page 66), what is the percentage of pregnancies when a condom is used?

16-8. 10% to 15%

Surgery is another birth-control method sometimes used by both males and females. It is used especially after a husband and wife have had all the children they plan to have. At present, there is no sure way that the operations can be reversed.

In females, the surgery involves cutting and tying or sealing the fallopian tubes. The surgeon must make a small incision in the woman's abdomen.

When the fallopian tubes are cut, eggs cannot pass from the ovaries through the tubes and into the uterus. Thus, fertilization cannot occur. Look at Figure 16-5 below.

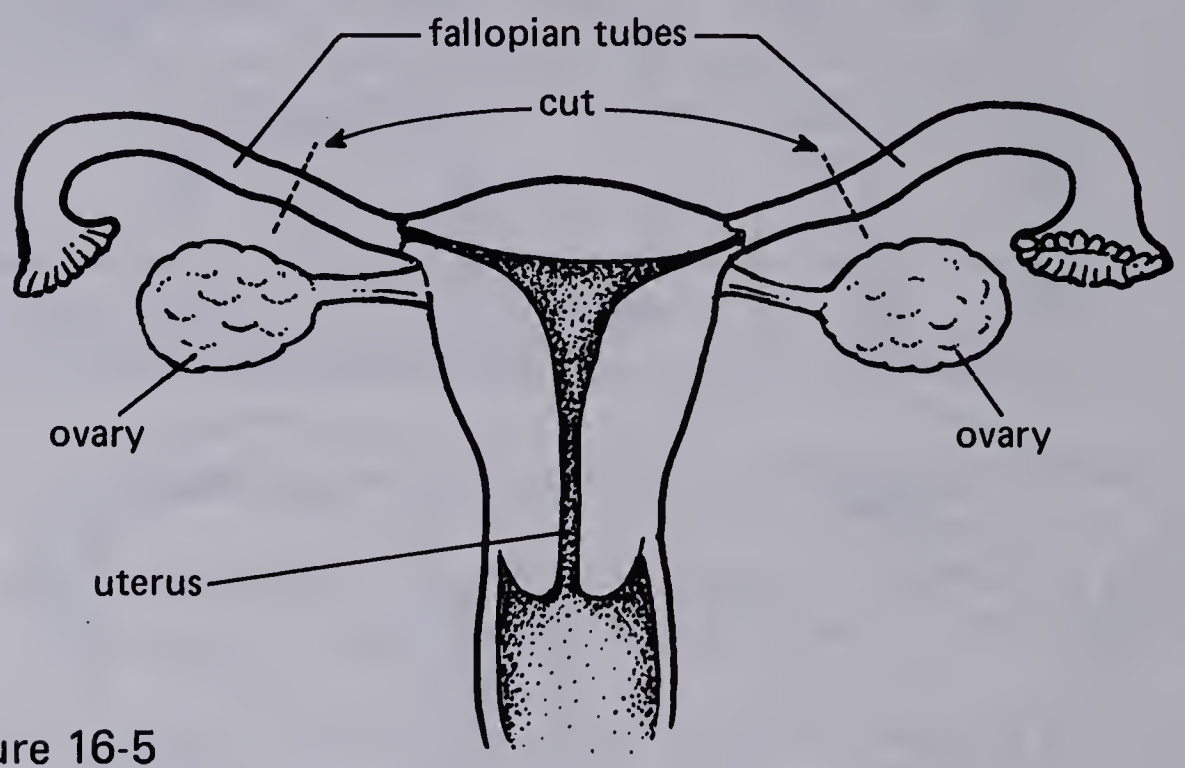


Figure 16-5

Cutting the fallopian tubes does not affect the sexual behavior or activities of the woman in any way.

● 16-9. How is pregnancy prevented by cutting the fallopian tubes?

16-9. The egg cannot travel through the fallopian tube to the uterus. The egg cannot be reached by the sperm, and fertilization cannot occur.

In males, the surgery also involves cutting and tying or sealing tubes. The surgeon makes a small incision through the wall of the scrotum. Each vas deferens is then cut and tied or sealed. Look at Figure 16-6 below.

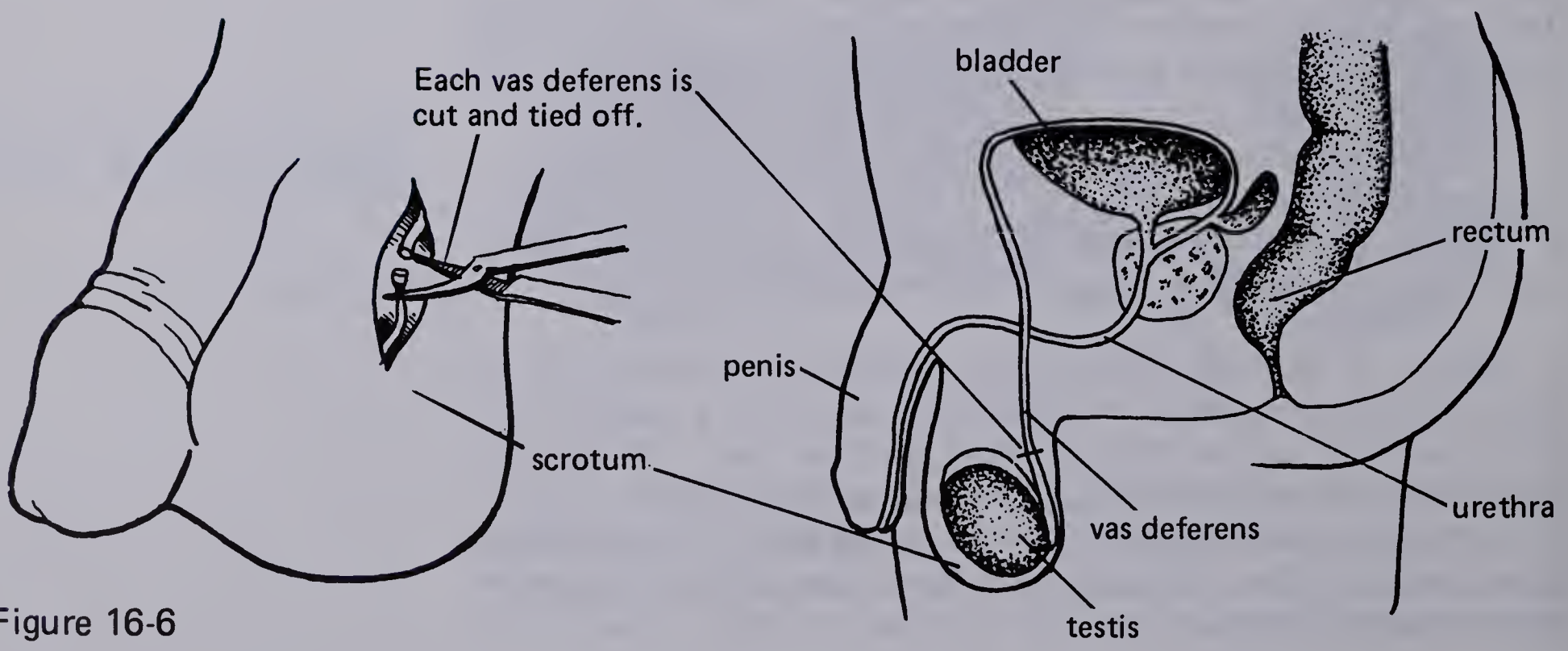


Figure 16-6

Cutting each vas deferens prevents sperm cells from being released during sexual intercourse. Semen is released, but no sperm are carried in it. There are no changes in the sexual behavior or activities of men when the tubes are cut.

☆ **16-10. According to Figure 16-1 (page 66), what is the percentage of pregnancies when tubes are cut?**

16-10. Almost 0%

● 16-11. Which of the six methods of birth control discussed in this activity require the care of a doctor?

16-11. IUD, diaphragm, pill, and tube cutting

☆ **16-12. Other than tube cutting, which method is the most effective in preventing pregnancies? The next most effective? Least effective?**

16-12. The pill; IUD; sperm-killing chemicals used alone

☆ **16-13. Match the birth-control method with the way it works.**

16-13. A4, B3, C2, D1, E6, F5, G7

Method	Way It Works
A. Birth-control pills	1. kills sperm in the vagina
B. Cutting fallopian tubes	2. unknown
C. IUD	3. prevents eggs from going through the fallopian tubes to the uterus
D. Sperm-killing chemical	4. many prevent ovulation
E. Condom	5. blocks opening from the vagina to the uterus
F. Diaphragm	6. collects sperm and keeps them from entering the vagina
G. Cutting vas deferens tubes	7. eliminates sperm from semen

Medical researchers are searching for new and more effective methods of family planning. After the new methods are tested for safety and effectiveness, they, too, will become available from clinics and doctors.

ACTIVITY EMPHASIS: The six most prevalent types of sex-related diseases are classified as venereal diseases. Their symptoms and treatment are discussed.

MATERIALS PER STUDENT LAB GROUP: None

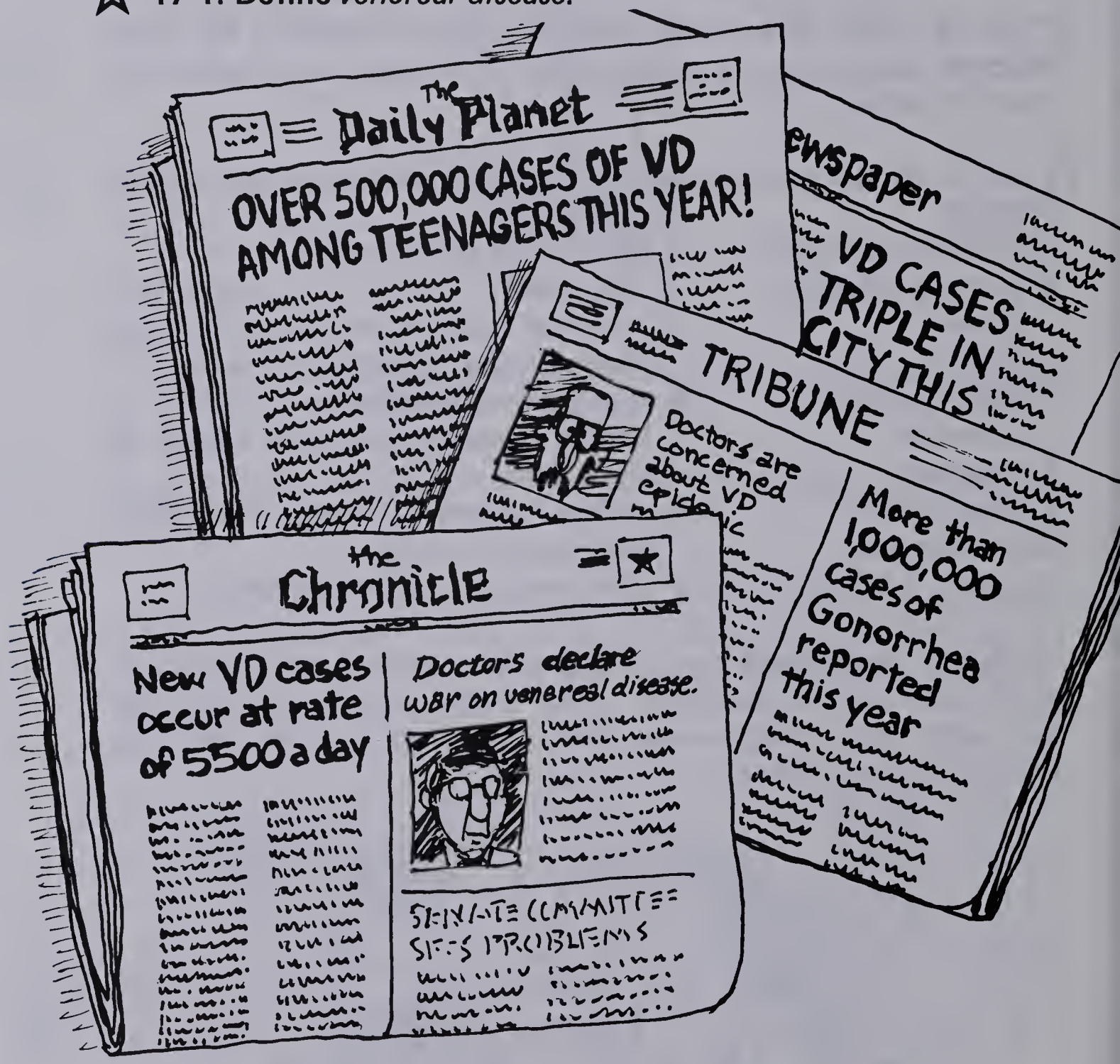
ACTIVITY 17: VENEREAL DISEASES

The letters *VD* stand for *venereal diseases.* A *venereal disease* can be defined as "a contagious disease commonly associated with the reproductive organs of a human male or female."

Originally, VD referred only to gonorrhea [gone-ah-RE-ah] and syphilis [SIF-i-lis]. However, several other infections could be classified in the same way. This activity discusses six that are most common.

17-1. A contagious disease commonly associated with the human reproductive organs

☆ **17-1. Define *venereal disease.***



Anyone can get VD. They may be young children or old people, rich or poor. They may be people from all sizes and types of communities and from any part of the country. They may be in any type of job or profession. VD can affect anyone. And the rate of infection is increasing.

17-2. Anyone

● 17-2. Who can be infected by venereal diseases?

GONORRHEA

You may have heard gonorrhea called *clap*. It is a serious disease. It is caused by bacteria that usually enter the body through the reproductive organs. The bacteria are transmitted by skin-to-skin contact, including kissing and usually, though not always, during sexual intercourse.

☆ **17-3. What causes gonorrhea?**

17-3. Bacteria

The bacteria that cause gonorrhea are known to occur only in human beings. Usually, these bacteria can live and reproduce only in moist environments. They don't survive in dry surroundings, so they enter the body through parts that have moist tissues — the throat and sexual and anal structures. The bacteria can't get into the body through unbroken outer skin.

● 17-4. How do the organisms that cause gonorrhea enter the human body?

17-4. Through body parts with moist tissue

Symptoms of gonorrhea differ in males and females and between different individuals. In males, it produces an infection of the urethra — the tube leading from the bladder to the outside. This is usually indicated by a discharge of pus and a painful, burning sensation during urination. The symptoms generally occur within two to ten days of getting the infection, but sometimes the period is much longer. In some males, symptoms of the disease never develop.

In females, there may be mild discomfort involving the cervix or no symptoms at all. Thus, with both males and females, it may be impossible to tell whether an infection is present without medical tests.

● 17-5. What are the symptoms of gonorrhea in males? In females?

17-5. Painful urination and discharge of pus; mild discomfort or no symptoms at all

If untreated, the infection may spread to other parts of the body. In males, this may involve the prostate gland and other structures all the way to the testes. In females, the uterus, fallopian tubes, ovaries, and other organs in the abdominal cavity may be affected. The infection of the fallopian tubes could be fatal. In both male and female, the infection may produce sterility, arthritis, and heart disease.

● 17-6. What are some of the possible serious results of gonorrhea?

17-6. Infection of body organs, sterility, arthritis, heart disease

Gonorrhea can be treated and cured by antibiotics. But it is important that it be done early to prevent damage to the body and possible infection of others.

SYPHILIS

You may have heard syphilis called *pox* or *sif*. It is also a very serious disease. Like gonorrhea, it is caused by bacteria that enter the body through moist tissues. In fact, the methods of transfer of gonorrhea and syphilis are the same. But the two diseases are not related in any other way. Gonorrhea occurs more often than syphilis. But syphilis produces more serious effects on the body.

17-7. By intimate contact through moist tissue

☆ **17-7. How are gonorrhea and syphilis transmitted from one person to another?**

The symptoms of syphilis occur in nine to ninety days, but usually in about three weeks. In the primary stage, a hard, raised pimple or sore, called a *chancre* [SHAN-ker] develops at the place where the infection entered the body. This seems to heal and go away within four weeks. In later stages, beginning two to four months after the infection, a rash and open sores appear. There may be fever, headache, nausea, and loss of clumps of hair. If untreated, the symptoms may disappear, only to reappear later in life. Finally, large ulcers may develop in any part of the body. There may be damage to the heart, blood vessels, nerves, and the brain. This can result in death, paralysis, or insanity.

17-8. The effects of syphilis are generally much more severe.

● 17-8. How do the effects of syphilis compare in general with the effects of gonorrhea?

Syphilis may not show symptoms in the female for long periods of time. Then during pregnancy, the disease can be transmitted to the developing baby. The baby may be born dead, blind, deaf, or severely deformed. Most states require a blood test prior to getting a marriage license so as to guard against syphilis being passed on to infants.

Like gonorrhea, syphilis can be successfully treated in the early stages with antibiotics. But in the later stages of syphilis, the treatment is much longer and more difficult. And the treatment cannot undo the tissue or organ damage that has already occurred.

17-9. By a blood test

● 17-9. How can a doctor test whether a patient has syphilis?

HERPES GENITALIS

Herpes genitalis [HER-pees jen-i-TAL-is] is a disease caused by a herpesvirus. There are two closely related strains of one herpesvirus called *herpes simplex.* One strain causes cold sores and fever blisters on the mouth. The other strain infects the genitals.

Just as cold sores can spread, so too can the blisters of this venereal disease. Two to twenty days after infection, the spot may tingle or burn. Then blisters develop. These soon break, forming painful ulcers. Without complications, these usually heal by themselves in one to two weeks. But the virus may cause the symptoms to return again and again.

The ulcers are especially painful on females. There has been shown to be a relationship between getting herpes infection and cancer of the cervix. The most severe complication of the disease is the infection of babies during birth. This is sometimes fatal to infants.

● 17-10. What are the main symptoms of herpes genitalis?

17-10. Burning, blisters, and then ulcers

TRICHOMONIASIS

Trichomoniasis [trik-o-mo-NI-a-sis] is a disease caused by a tiny parasite. It is sometimes called *trik*. Although males can get the disease, the symptoms are much more obvious in females. It causes an inflammation of the vagina with severe itching and a frothy discharge. The discharge may stain undergarments and cause a bad odor.

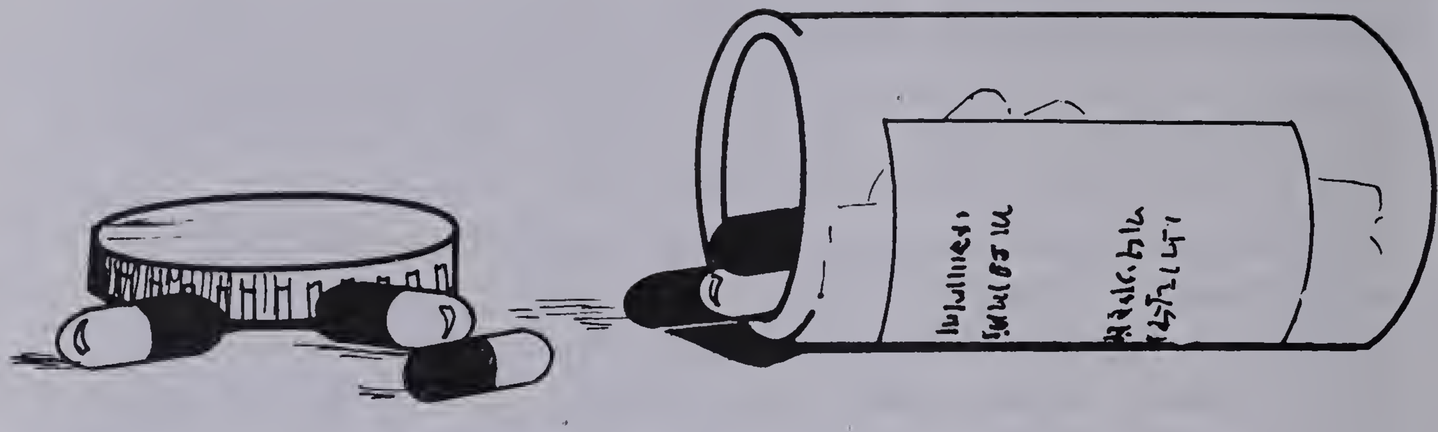
The infection can be cured by a medicine called *Flagyl*. Although this infection is not as serious as some other venereal diseases, the symptoms can be very annoying to females.

PEDICULOSIS

Pediculosis [ped-i-kue-LO-sis] is a disease caused by blood-sucking lice about one to four millimetres long. It is sometimes called *crabs*. The lice can be spread by clothing, towels and bedding, and toilets, as well as by intimate contact. The itching caused by the lice is usually severe. The disease can be cured with an ointment.

CANDIDIASIS

Candidiasis [kan-di-DI-a-sis] is a yeast infection. It is caused by a fungus that is normally found in the internal organs of most healthy people. When the body is upset, the fungus may increase in numbers. Then it causes an inflammation of the vagina or the penis. It produces severe itching and a thick, white, curdy discharge. Treatment consists of lowering the yeast level so that the symptoms disappear.



17-11. Yes

● 17-11. Can all of the venereal diseases described be cured?

VD can be cured. But the body does not build up an immunity as it does for some diseases. Therefore, a person can be reinfected again and again.

17-12. They should go to a clinic or doctor immediately.

● 17-12. What should people do if they think they have VD?

WHAT YOU CAN DO ABOUT VD

1. If you think you may have the symptoms of VD or have had close contact with anyone who has, go to a doctor or clinic for medical advice and a checkup. If you don't know where to go, ask your teacher, parents, counselor, or someone you trust. Or look in the phone book to find the number and location of a public health clinic.

2. Explain the dangers of VD to friends. Encourage them to seek medical advice if they have symptoms of the disease or have been in close contact with anyone who has it.

3. Do not have close contact with other persons who you think may have VD.

4. People who have sexual relationships with several different people are more likely to have VD. Therefore, it's wise to avoid having sexual relationships with those who have sexual relationships with several people.

5. Remember that even if the symptoms seem to disappear on their own, this does not mean that the disease is cured. It's probably only latent. And it will still require treatment to cure later when the damage to the body may be greater.

6. A male can use a condom during sexual intercourse. This may help protect a partner without VD from the partner with VD.

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